Cypress Ridge System Water Master Plan

Golden State Water Company

December 2019

Executive Summary

Purpose

The purpose of this Master Plan is to assess Golden State Water Company's (GSWC) Cypress Ridge System's ability to meet current and future water needs, and to identify upgrades needed if deficiencies exist. This assessment is developed by using hydraulic analysis criteria, future demands and available supply, water quality standards, and condition of facilities.

These updates provide GSWC with a basis to determine the impacts of new development on the existing system and to identify system deficiencies and improvements needed to correct them. These system improvement needs are used as the basis for developing the Capital Improvement Program (CIP) for the system. TABLE 9-1 summarizes the CIP projects identified in this master plan.

GSWC's goal is to meet the minimum requirements identified in the technical memorandum titled *Golden State Water Company Master Planning Criteria and Standards* (see Appendices).

Master Plan Process

This master plan document is organized as follows:

- Update existing system information
- Establish existing demands and forecast future demands
- Update system's hydraulic model
- Evaluate supply and storage capacities
- Perform hydraulic analyses and evaluation
- Identify water quality issues
- Assess condition of facilities in the system
- Develop CIP

Contents

Appendices (provided on CD)

Tables

Figures

Acronyms and Abbreviations

1,1-DCE	1,1-dichloroethylene
2017 WMP	Cypress Ridge 2017 Water Master Plan
AACE International	Association for the Advancement of Cost Engineering International
ADD	average day demand
AFY	acre-feet per year
amsl	above mean sea level
AOB	ammonia-oxidizing bacteria
CIP	capital improvement program
CPUC	California Public Utilities Commission
DDW	State Water Resources Control Board, Division of Drinking Water
DPB Rule	Disinfectants and Disinfection Byproducts Rule
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FCV	flow-control valve
fps	foot or feet per second
GAC	granular activated carbon
gpm	gallons per minute
GSWC	Golden State Water Company
GWO	General Work Order
HPC	heterotrophic plate count
IDSE	Initial Distribution System Evaluation
MCL	maximum contaminant level
MDD	maximum day demand
MG	million gallons
MHD	minimum hour demand
NAICS	North American Industry Classification System
NOB	nitrite-oxidizing bacteria

O&M	operations and maintenance
PCE	tetrachloroethylene
PHD	peak hour demand
PRV	pressure-regulating valve
psi	pounds per square inch
PSV	pressure-sustaining valve
SCADA	supervisory control and data acquisition
SDWA	Safe Drinking Water Act
TDS	total dissolved solids
TTHM	total trihalomethanes
VOC	volatile organic compound
WMP	Water Master Plan

SECTION 1

Introduction

1.1 Overview of Golden State Water Company

GSWC is a subsidiary of American States Water Company, an investor-owned utility dedicated to increasing value through the expert management of utility assets and services. As a public utility, GSWC is committed to the purchase, production, distribution, and sale of water to over 260,000 customer connections.

GSWC is organized into three regions throughout the state of California. Region I is located in northern and central coast of California. Region II serves communities in Los Angeles County. Region III serves communities in Los Angeles, San Bernardino, Imperial, and Orange counties.

FIGURE 1-1, provided at the end of this section, shows the locations of all GSWC water systems.

1.2 Master Plan Update

The purpose of this master plan is to assess the Cypress Ridge System's ability to meet current and future water needs and recommend system upgrades needed to meet current customer needs. This assessment is developed by using hydraulic design criteria, water quality standards, system demands and available supply, and facility condition assessments.

Specifically, this master plan supports GSWC's effort to update existing master plans and hydraulic models for water systems throughout the company. These updates provide GSWC with a baseline for determining the impacts of new development on existing systems as well as identifying short, mid, and long term system needs. These system needs are used as the basis for developing the capital improvement program (CIP) for the system. The primary drivers of this master plan update are the following:

- Assess the distribution system's hydraulic performance
- Identify infrastructure that is in poor condition and needs to be replaced
- Identify supply and storage needs
- Identify water quality and treatment needs
- Provide documentation for the proposed CIP projects in support of the General Rate Case for the California Public Utilities Commission (CPUC)
- Reduce operations and maintenance (O&M) efforts and costs required to maintain service under current conditions
- Minimize service failures

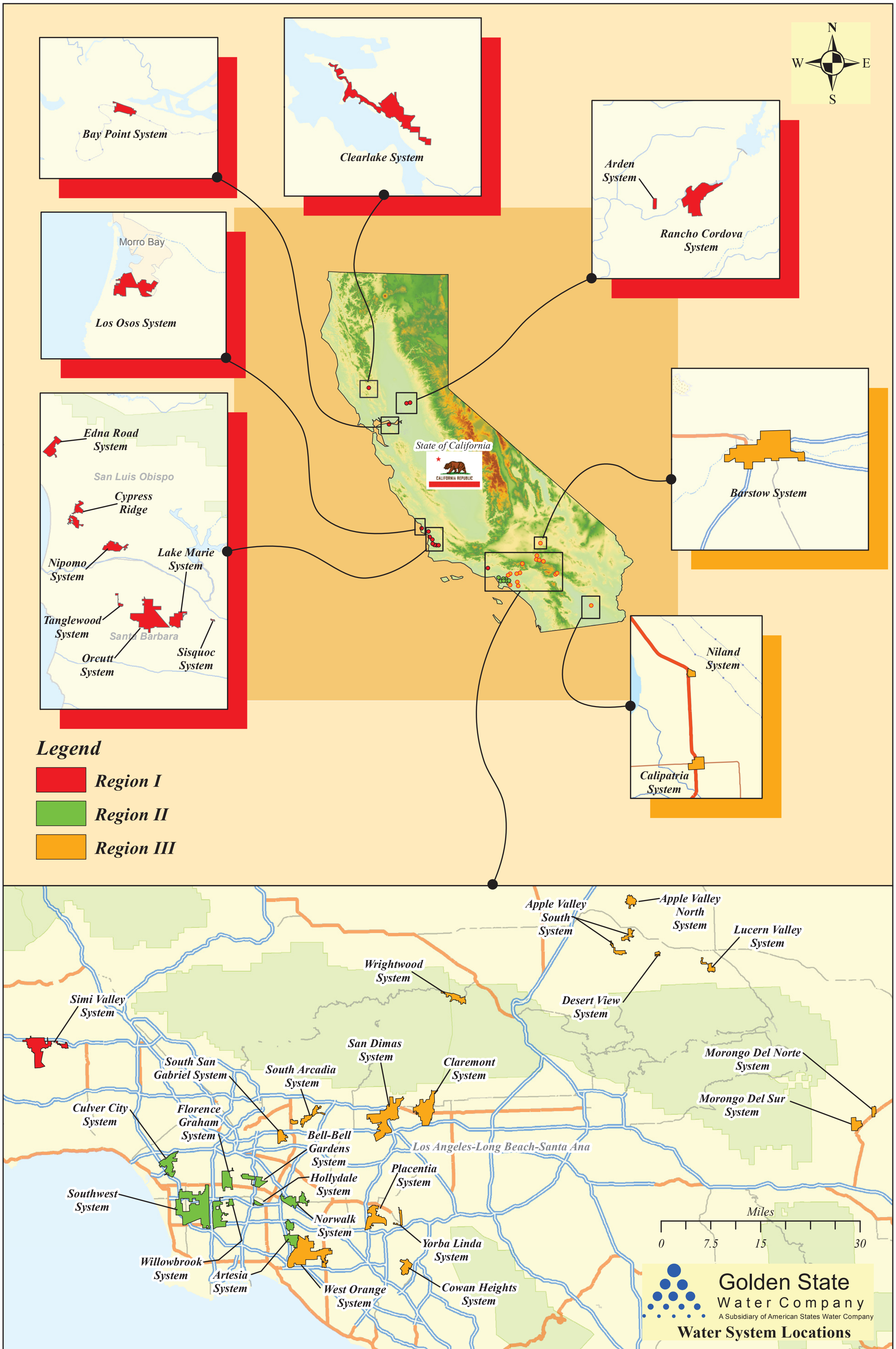
1.3 Document Organization

This master plan document is organized to provide information in a sequential manner that considers historical progression (past to present to future) and logical evaluation of the system from existing facilities and requirements through future needs. Each section's title and a brief summary are as follows:

1. **Introduction:** Provides background information on the company and its systems.
2. **Existing Water System Facilities:** Provides an overview of the system and its facilities. System facilities identified include the system service area boundary, pressure zones, distribution areas, supply sources, storage facilities, pump stations, pressure regulating and water control stations, and transmission and distribution pipelines.
3. **Existing and Future Demands:** Provides definition of demand types and periods, as well as existing and future demands. Explains the demand development approach and determination of peaking factors. Provides the current demands and projected demands developed for a future 2040 condition. Future demands are based on population growth rate and water use projections.
4. **Hydraulic Model Development and Calibration:** Provides an overview of the modeling process, including hydraulic model construction and calibration.
5. **Supply and Storage Capacity Evaluation:** Documents the evaluation of the system's water supply and storage capacity using the objectives identified in GSWC's *Master Planning Criteria and Standards.* The evaluation results establish supply and storage needs for each distribution area and the entire distribution system. Existing and future supply and storage deficiencies are also identified. Recommended improvements to mitigate deficiencies are also provided.
6. **Hydraulic Analysis and Evaluation:** Outlines the approach for the hydraulic analysis. Details how the updated hydraulic model was used to determine hydraulic deficiencies under simulated demand scenarios and was compared with the analysis and planning criteria for short, mid, and long term planning periods. Provides recommendations to address deficiencies that were identified. Scenarios simulated by the hydraulic model include average day, maximum day, and peak hour conditions.
7. **Water Quality Analysis:** Provides GSWC's evaluation of water quality based on current and pending federal and state standards and rules.
8. **System Condition Assessment:** Provides GSWC's documentation of system condition assessment efforts including past efforts, recent field inspections, and recommendations for future improvements.
9. **Capital Improvement Program:** Describes the CIP plan resulting from all preceding tasks broken down into short, mid, and long term planning periods. This includes prioritization and justification for the projects included in the CIP.
10. **References:** Lists the primary sources of information referred to throughout the master plan.

Appendices provide supporting information on various specifications and details referred to throughout the master plan.

Figures



GSWC Engineering Planning October 2017

SECTION 2

Existing Water System Facilities

This section documents existing water system facilities for the Cypress Ridge System. Detailed information about the major facilities, such as water supply facilities, storage facilities, pipelines, pumping facilities, and regulating valves serves as the basis for subsequent system analysis throughout the master plan. This section begins with an overview of the system, and then presents detailed information about these facilities.

2.1 Overview

The Cypress Ridge System is located in San Luis Obispo County, covers approximately 2.6 square miles, and serves an unincorporated portion of the County near the City of Arroyo Grande and the golf course community of Cypress Ridge. The Cypress Ridge System was acquired by GSWC in 2015.

The Cypress Ridge System obtains its water supply from the Santa Maria Groundwater Basin through eight active groundwater wells.

The system includes approximately 28 miles of pipelines ranging from 2 to 10 inches in diameter.

2.2 Facility Descriptions

The major system facilities are shown in FIGURE 2-1 at the end of this Section. These facilities are discussed in detail in the following subsections:

- Pressure zones
- Supply sources
- Storage facilities
- Pumping stations
- Pressure regulating stations and flow control stations
- Transmission and distribution pipelines

2.2.1 Pressure and Distribution Zones

The Cypress Ridge System is comprised of two pressure zones, the Main Zone and the Indian Hills Zone. The Main Zone functions as two separate distribution areas – referenced in this Master Pan as the 'Main Zone' and the 'Cypress Ridge Zone' – based on a normally-closed system valve and the geographic network of the distribution piping. TABLE 2-1 provides details of these pressure zones and lists the PRVs and/or booster stations that connect the zones. FIGURE 2-2 presents the system's hydraulic profile (schematic of the water system).

TABLE 2-1 Pressure Zone Details

Pressure Zone	HGL (ft msl)	Elevations Served (ft msl)	Supply and Storage Facilities[a]		
			Storage Tanks	Wells and Purchased Water	PRV/Booster Station
Main Zone	430	75–312	El Campo Reservoirs #1 & #2, Falcon Crest Reservoir	Lopez High Wells #8 & #9, Fowler Well #3, Ridgemont Wells #4 & #7 and El Campo Wells #2 & #6	El Campo Booster Station, Falcon Crest Booster Station 2 PRVs from Indian Hills Zone
Cypress Ridge Zone[b]	405	185-317	Cypress Ridge Reservoirs #1 & #2	Cypress Ridge Wells #4, #5, #6 & #7	Cypress Ridge Booster Station
Indian Hills Zone	550	283–412	-	-	Indian Hills Booster Station

[a] Does not include hydropneumatic tanks or emergency interconnections.
[b] Distribution area within Main Zone, separated by a single normally-closed valve.

2.2.2 Supply Sources

GSWC currently obtains its water supply for the Cypress Ridge System from one primary source: GSWC owned and operated groundwater wells. The Cypress Ridge System has no emergency interconnection.

Groundwater

The system has nine active and five non-operational wells; their locations are identified in FIGURE 2-1. The finished water meets all applicable state and federal water quality standards for potable water.

Active Wells

Nine groundwater wells were identified as active for this master plan. TABLE 2-2 presents the relevant data for these wells. The elevation shown for each well is the elevation of the wellhead facilities. The pumping water level is the depth measured from the wellhead to the surface of the groundwater while the well pump is running. Pumping water levels were based on recent levels monitored and recorded by GSWC. The groundwater elevation was calculated by subtracting the pumping water level from the wellhead elevation. Total dynamic head (TDH) represents the amount of energy required by the pump to produce water at the given flow rate. The capacity is the flow rate that the pump was designed to deliver. None of the wells in the Cypress Ridge System have backup power.

TABLE 2-2 Active Wells

Well	Discharge Location	Wellhead Elevation (ft msl)	Pumping Water Level (ft)	Pumping Groundwater Elevation (ft msl)	TDH[a] (ft)	Capacity[a,b] (gpm)
Club House – CR #4	Cypress Ridge Reservoirs	294	307	-13	325	125[c]
Auklet – CR #5	Cypress Ridge Reservoirs	242	275	-33	344	60
Wigeon – CR #6	Cypress Ridge Reservoirs	275	310	-35	340	125
Brant – CR #7	Cypress Ridge Reservoirs	260	320	-60	354	70
El Campo – RW #2	El Campo Reservoirs	289	282	7	328	120
El Campo – RW #6	El Campo Reservoirs	283	269	14	326	100
Fowler – RW #3	Main Zone	126	146	-20	447	270
Ridgemont – RW #4	El Campo Reservoirs	243	281	-38	350	160
Ridgemont – RW #7	El Campo Reservoirs	247	264	-17	338	110
Total groundwater production capacity						**1,140**

msl: above mean sea level

[a] TDH and Capacity based on pump design point data, when available, or pump data sheets received upon acquisition of system from Rural Water Company; adjusted as necessary based on recent pump test results.
[b] Capacity is based on facility design capacity, under normal operating conditions, and may not reflect actual capacity at a given point in time.
[c] The Club House well has experienced a significant loss in yield; 2018 pump test results show the normal operating point as 40 gpm @ 324 ft TDH. As of the publication date of this Master Plan, this well is non-operational due to high nitrates.

Non-operational Wells

The Cypress Ridge System has five non-operational wells; details are provided in TABLE 2-3.

TABLE 2-3 Non-Operational Wells

Well	Discharge Location	Elevation (ft msl)	Previous Capacity (gpm)	Reason
Avocet – CR #8	Cypress Ridge Reservoirs	283	N/A	High nitrates; low yield
El Campo – RW #1	Main Zone	276	N/A	Sediment entrained in well discharge
El Campo – RW #5	Main Zone	281	N/A	Elevated iron concentration; low yield
Lopez High – RW #8[a]	Main Zone	103	300	High nitrates

Lopez High – RW #9	Main Zone	111	175	High nitrates

[a] Historical TDH stated as 220 ft.

Purchased Water

There are no existing purchased water connections for the Cypress Ridge System. However, establishment of a purchased water connection is required in order to import water to the Cypress Ridge System.

The Santa Maria Groundwater Basin has been the subject of ongoing litigation since 1997 due to periods of falling groundwater levels, the potential for seawater intrusion into the Santa Maria Basin as a result of large depressions in the Nipomo Mesa Sub-basin, and competing claims to water resources. As a means of ensuring the Basin's long term sustainability, the California State Superior Court of Santa Clara County approved a Settlement Stipulation in June 2005, containing a requirement that Nipomo Mesa water purveyors – including GSWC, the Nipomo Community Services District (NCSD), Woodlands Mutual Water Company and Rural Water Company (now GSWC's Cypress Ridge System) – procure and import supplemental water to the Nipomo Mesa Management Area (NMMA) in the quantity of a minimum of 2,500 acre-feet per year (AFY). As a party to the Settlement Stipulation, GSWC is responsible for purchasing 16.66 percent (approximately 416.5 AFY) of the 2,500 AFY (800 AFY in Years 2016-2020, 1,000 AFY in Years 2021-2025 and 2,500 AFY in Years 2026 and beyond) to the Nipomo Mesa.

A pipeline, the Waterline Intertie Project, was recently completed and is conveying water from the City of Santa Maria to the NMMA. In addition, GSWC and NCSD are in process of constructing a project to connect the NCSD distribution system and the Cypress Ridge System; interconnection facilities at Lyn Road are planned for 2020 Q4 construction, and a pipeline from the interconnection location to the El Campo Plant is near completion.

TABLE 2-4 Imported Water Supply Connections

Imported Water Supply Connection	Hydraulic Grade Line (ft)	Capacity (gpm)	Pressure Setting at Connection* (psi)	Ground Surface Elevation (ft msl)	Imported Water Supply Pipeline
-	-	-	-	-	-

Emergency Interconnections

Water distribution systems are often connected to neighboring water systems to allow the sharing of supplies during short-term emergencies or during planned shutdowns of a primary supply source. The Cypress Ridge System has no emergency interconnection, as presented in TABLE 2-5.

TABLE 2-5 Emergency Interconnections

Interconnection Name/Location	Capacity* (gpm)	Notes
-	-	-

* Capacity of an emergency interconnection is not considered a reliable supply; rather, it is considered an "interruptible" supply, as it is based on whether or not the neighboring water agency has available water.

2.2.3 Storage Facilities

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand, to supply sufficient water for firefighting, and to meet demands during an emergency or an unplanned outage of a major supply source. This section describes the existing storage facilities in the system.

Storage Tanks

The Cypress Ridge System has five operational storage tanks. A summary of the reservoirs is provided in TABLE 2-6.

TABLE 2-6 Storage Tanks

Tank	Type and Zone	Bottom of Tank (ft msl)	High Water Elevation (ft msl)	Tank Height (ft)	Diameter (ft)	Volume (MG)
Cypress Ridge 1 (North)	Ground level pumped to Cypress Ridge Zone	268	283	16.1	54.9	0.275
Cypress Ridge 2 (South)	Ground level pumped to Cypress Ridge Zone	268	283	16.1	54.9	0.275
El Campo 1 (Northeast)	Ground level pumped to Main Zone	281	310	32	33	0.20
El Campo 2 (Southwest)	Ground level pumped to Main Zone	281	310	30	36	0.22
Falcon Crest	Ground level, gravity or pumped[a] to Main Zone	312.5	335	24	38	0.212
Total systemwide storage capacity						**1.182**

[a] The Falcon Crest Boosters are set to come on based on time of day (peak demand conditions); when the booster pumps are not operating, the storage capacity in the tank is available to flow by gravity to the Main Zone.

2.2.4 Pumping Stations

Pumping stations are required to convey water from ground-level tanks into the distribution system or from lower-pressure zones into higher-pressure zones (usually called booster pumping stations). Pumping stations may consist of one or more individual pumps. Multiple pumps at each station, or multiple pumping stations that serve the same pressure zone, help to increase water system reliability by ensuring that water can still be delivered into that zone if one pump is out of service. Critical pumping stations may be equipped with emergency power supplies in case of failure of the primary power source.

The Cypress Ridge System has sixteen booster pumps, located at four active booster stations. TABLE 2-7 presents pump data relevant to the water system analysis.

TABLE 2-7 Booster Pumps

Facility	Pressure Zone		Backup Power Available	Elevation (ft msl)	TDH[a] (ft)	Capacity[a] (gpm)
	Suction	Discharge				
Cypress Ridge Booster A	Cypress Ridge Tanks	Cypress Ridge Zone	-	266	125	250
Cypress Ridge Booster B	Cypress Ridge Tanks	Cypress Ridge Zone	-	266	130	400
Cypress Ridge Booster C	Cypress Ridge Tanks	Cypress Ridge Zone	Diesel Generator	266	125	2,000
Cypress Ridge Booster D[b]	Cypress Ridge Tanks	Cypress Ridge Zone		N/A	N/A	N/A
El Campo Booster A	El Campo Tanks	Main Zone	-	281	118	56
El Campo Booster B	El Campo Tanks	Main Zone	-	281	116	215
El Campo Booster C	El Campo Tanks	Main Zone	-	281	111	194
El Campo Booster D	El Campo Tanks	Main Zone	-	281	152	417
El Campo Booster E[c]	El Campo Tanks	Main Zone	Propane	281	N/A	N/A
Indian Hills Booster A	Main Zone	Indian Hills Zone	-	287	95	104
Indian Hills Booster B	Main Zone	Indian Hills Zone	-	287	88	93
Indian Hills Booster C	Main Zone	Indian Hills Zone	-	287	92	58
Indian Hills Booster D	Main Zone	Indian Hills Zone	Gas powered	287	72	98
Falcon Crest Booster A	Falcon Crest Tank	Main Zone	-	315	81	80
Falcon Crest Booster B	Falcon Crest Tank	Main Zone	-	315	84	173
Falcon Crest Booster C	Falcon Crest Tank	Main Zone	Diesel Generator	315	84	211

msl: above mean sea level

[a] TDH and Capacity based on pump design point data, when available, or pump data sheets received upon acquisition of system from Rural Water Company; adjusted as necessary based on recent pump test results.
[b] Booster currently disconnected from system.
[c] No pump curve/data available.

2.2.5 Pressure Regulating and Flow Control Stations

Pressure regulating and flow control stations allow distribution systems to transfer water from higher pressure zones to lower pressure zones without exceeding the allowable pressures in the lower zones or completely depressurizing the higher zone. The water is transferred through a valve that reduces the pressure or controls the flow rate to a specified setting. Regulating valves can operate based on one or more controlling parameters. The operational controls important to this analysis include pressure reducing, pressure sustaining, pressure relief, and flow rate:

- **Pressure reducing valve:** modulates to maintain a preset minimum downstream pressure setting; if the downstream pressure drops, then the valve will open until the downstream pressure matches the pressure setting.
- **Pressure sustaining valve:** modulates to maintain a preset minimum upstream pressure setting; if the upstream pressure drops, then the valve will close until the upstream pressure matches the pressure setting.
- **Pressure relief valve:** opens when the upstream pressure exceeds a preset maximum pressure setting.
- **Flow control valve:** modulates to maintain a preset flow rate through the valve regardless of pressure.

There are eight pressure regulating valves in the Cypress Ridge System. TABLE 2-8 lists the relevant data for these valves.

TABLE 2-8 Pressure Regulating and Flow Control Valves

	Pressure Zone					Maximum
Name/Location	Upstream	Downstream	Type	Dia. (in)	Setting (psi)	Capacity (gpm)
Sevada Ln. and Arabian Way	Indian Hills Zone	Main Zone	PRV	N/A	N/A[a]	N/A
Tolbert Pl. and Welsh Ln.	Indian Hills Zone	Main Zone	Relief Valve	2	115	210
Cypress Ridge Plant	Cypress Ridge Zone	Cypress Ridge Tanks	Relief Valve	N/A	75	N/A
Indian Hills Plant	Indian Hills Booster D	Indian Hills Zone	PRV	N/A	100	N/A
El Campo Plant	Main Zone	El Campo Tanks	Altitude Valve w/ PSV	N/A	60	N/A
El Campo Plant	Main Zone	El Campo Tanks	Relief Valve	N/A	75	N/A
Falcon Crest Plant	Main Zone	Falcon Crest Tank	Altitude Valve	N/A	Tank level	N/A
Falcon Crest Plant	Main Zone	Falcon Crest Tank	Relief Valve	N/A	65	N/A

[a] PRV is currently closed; consider replacement with check valve.

2.2.6 Transmission and Distribution Pipelines

The Cypress Ridge System has a total of 28 miles of pipelines ranging in diameter from 2 to 10 inches. TABLE 2-9 lists the estimated footage of pipelines by diameter and material.

TABLE 2-9 Pipes by Size and Material

Diameter (in)	Length of Pipe by Material (ft)				Total Length (ft)
	AC	DI	PVC	STL	
2	-	32	34	-	**66**
3	-	40	72	-	**112**
4	90	241	2,488	-	**2,818**
6	4,315	6,239	22,193	3,513	**36,260**
8	8,201	764	94,170	166	**103,301**
10	-	-	4,102	95	**4,197**
Totals (ft)	12,606	7,316	123,059	3,774	**146,754**
Totals (mi)	2.4	1.4	23.3	0.7	**27.8**
Percent (%)	8.6	5.0	83.9	2.6	**100**

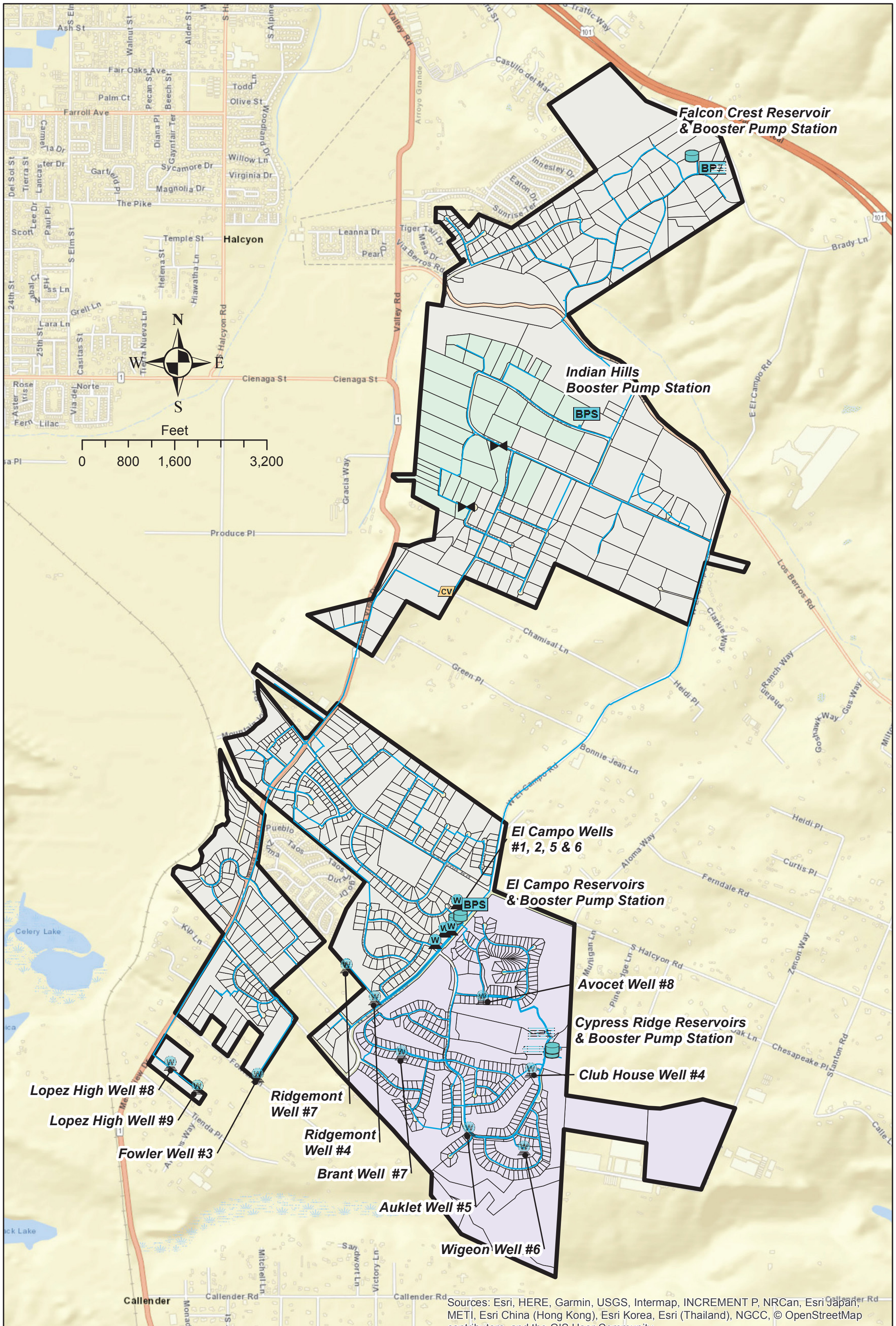
AC: asbestos cement or transite
DI: ductile iron
PVC: polyvinyl chloride
STL: steel

TABLE 2-10 lists the estimated footage of pipelines by diameter and year constructed.

TABLE 2-10 Pipes by Size and Year Built

Diameter (in)	Length of Pipe by Year Built (ft)			Total Length (ft)
	1960-1979	1980-1999	2000-2019	
2	-	66	-	**66**
3	-	112	-	**112**
4	-	2,818	-	**2,818**
6	3,104	33,156	-	**36,260**
8	813	89,847	12,641	**103,301**
10	-	4,197	-	**4,197**
Totals (ft)	3,917	130,195	12,641	**146,754**
Totals (mi)	0.7	24.7	2.4	**27.8**
Percent (%)	2.7	88.7	8.6	**100**

Figures



Existing Facilities

- Supply Connection
- Reservoir
- Well
- Emergency Interconnection
- Booster Pump Station
- Hydropneumatic Tank
- Regulating Valve
- Check Valve

Pressure Zones

- Main Zone
- Indian Hills Zone
- Cypress Ridge Zone

- Cypress Ridge System Boundary

Pipelines

- Less than 8"
- 10" or Greater

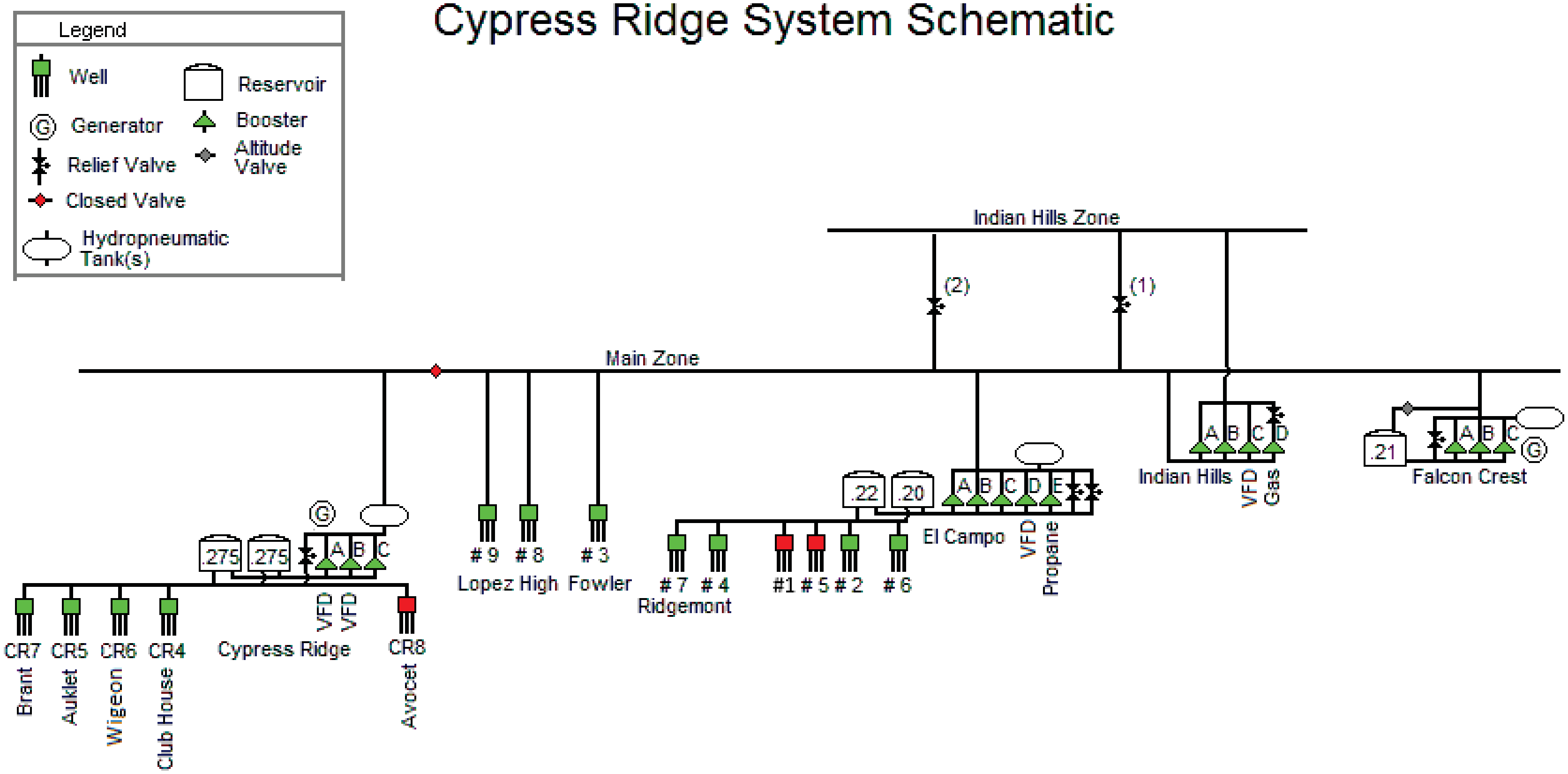
FIGURE 2-1
CYPRESS RIDGE SYSTEM OVERVIEW MAP

GSWC REGION I WATER MASTER PLAN
CYPRESS RIDGE SYSTEM

Golden State Water Company
A Subsidiary of American States Water Company

Last Update: 3/12/2019

Cypress Ridge System Schematic



PRV Stations
(1) - Seveda & Arabian
(2) - Tolbert & Welch

FIGURE 2-2
SYSTEM SCHEMATIC
GSWC REGION I MASTER PLAN
CYPRESS RIDGE SYSTEM

Golden State
Water Company
A Subsidiary of American States Water Company

SECTION 3

Existing and Future Water Demands

This section documents existing and future water demands for the system and contains the following information:

- Demand definitions and scenarios
- Existing demands
- Peaking factors
- Future demand projections

3.1 Demand Definitions and Periods

Demand is classified in two basic ways:

- Demand: The total quantity of water required for a given period of time to meet the water system's various uses. These uses may include residential, commercial, industrial, and other revenue and non-revenue demands.
- Non-revenue water: The difference between the total amount of water produced from water supply sources and the total amount of water delivered to customers. This includes water used for firefighting, flushing, water lost due to system leaks and illegal connections. For systems without meters for all customers, this demand classification may not be quantifiable.

The water industry commonly uses several demand periods for developing water distribution system master plans. These demand periods are designated as average day demand (ADD), maximum day demand (MDD), peak hour demand (PHD), and maximum day demand plus fire flow (MDD+FF), and were applied as necessary to evaluate the system. The American Water Works Association (AWWA, 2005) defines these common steady-state demand periods as follows:

- ADD: Total amount of water delivered to the system in 1 year divided by 365 days.
- MDD: Maximum amount of water delivered to the system in any single day of the year.
- PHD: Amount of water required to meet peak demands during MDD. GSWC applies PHD for four hours when analyzing system supply and storage.
- MDD+FF: Amount of water required to fight a fire in addition to MDD.

3.2 Existing Demands

The existing demands represent a baseline for evaluating the existing system and to project future demands. The data used to develop the existing demands was based on historical water production data provided by GSWC. As the Cypress Ridge System was acquired by GSWC in 2015, only four years of historical water production data was available for this analysis.

3.2.1 Historical Water Use

For this master plan, it was assumed that the historical water production equaled the historical water demand (including non-revenue water). TABLE 3-1 summarizes historical annual water production from 2015 through 2018. The average water demand per connection for this period was 0.597 acre-feet per year per connection (AFY/conn.).

TABLE 3-1 Historical Annual Water Production

Year	Active Service Connections	Total Demand (AFY)*	Average Demand per Connection (AFY/conn.)
2015	958	651	0.679
2016	958	557	0.581
2017	958	531	0.555
2018	962	551	0.573
10-year average			**0.597**

* Includes non-revenue water use

FIGURE 3-1 summarizes the historical annual water production and number of active service connections. The figure demonstrates a correlation between the number of active service connections and the amount of water consumed. The average demand per connection varied between 0.555 and 0.679.

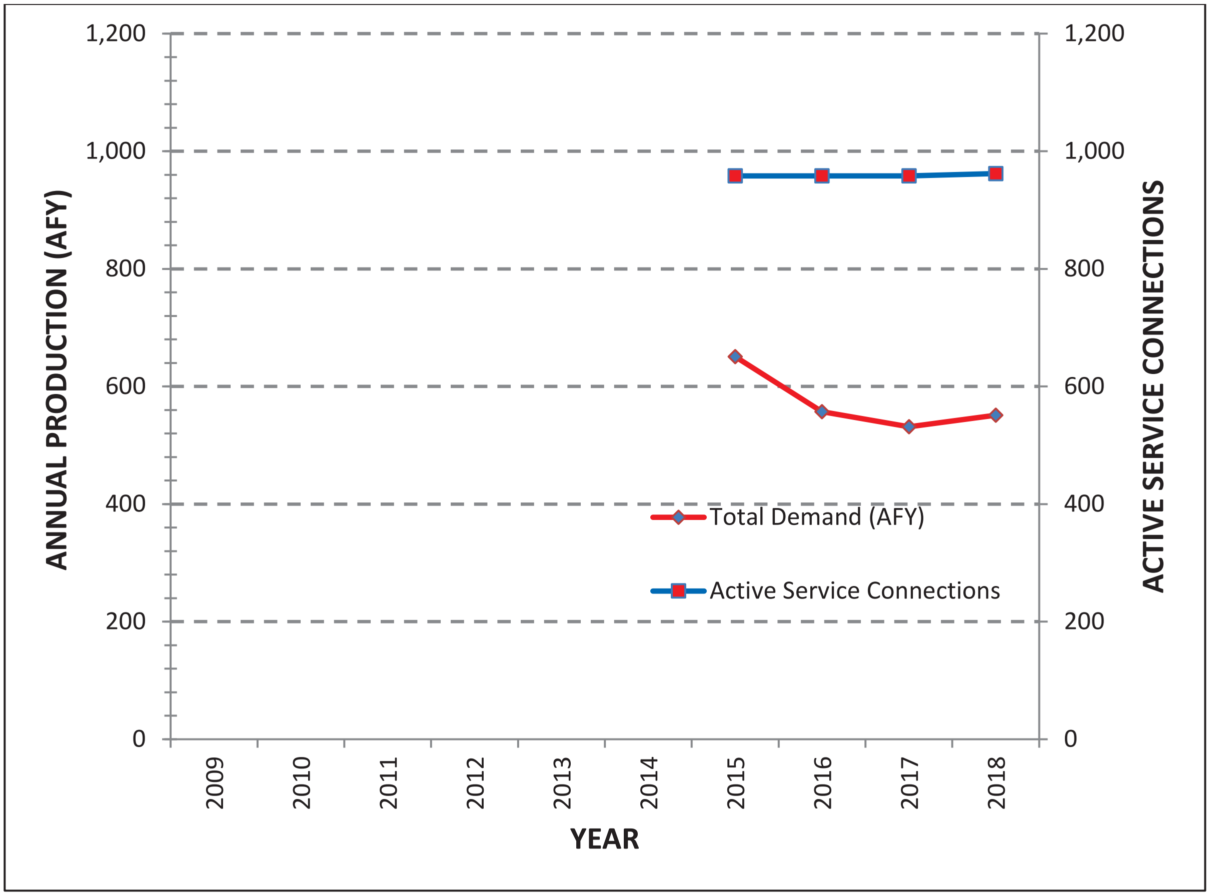


FIGURE 3-1 Historical Annual Production Totals and Active Service Connections for the Last 10 Years

3.2.2 Establishing Demands

The total water demand for existing conditions was estimated by multiplying the number of 2018 active service connections (962) with the four-year average of the average demand per service connection (0.597 AFY/conn.), resulting in a system water demand of 574 AFY. Converting the system water demand to a daily demand produces an ADD of 356 gpm. This approach allows the calculation of ADD for various planning years, including the impact on anticipated growth, and then allows a direct calculation for other demand periods using the appropriate peaking factor.

To evaluate the system's performance during the MDD scenario, existing historical demand data were used in accordance with the Waterworks Standards set forth by the California Code of Regulations (2009). Section 64554.30 of the Waterworks Standards define MDD as "the amount of water utilized by customers during the highest day of use (midnight to midnight), excluding fire flow, as determined pursuant to Section 64554." Section 64554(b)(1) of the Waterworks Standards states "…identify the day with the highest usage during the past ten years to obtain MDD…". While GSWC is currently unable to track customer usage over an exact 24-hour period, GSWC does record daily water production – and, as stated in Master Plan Section 3.2.1, above, it can be "assumed that the historical water production equal[s] the historical water demand". However, because the daily production reads are not taken at midnight or always collected at the same time each day, the resulting data may be for time periods that can range anywhere from 16 to 32 hours (depending on the time of day the production data are collected). For example, the readings may be taken at 9am one day and 4pm the next; this introduces the chance of a fairly large error if only the recording for a single day is used, as it could include water production over a period longer than 24 hours. To address the possible variations in the hours per day within a given production read, GSWC identifies and uses the average of the three consecutive days with the highest production for each calendar year. By utilizing the average of these highest three consecutive days of water production, the resulting number is normalized, reducing the effect of any imprecision due to the time of day when the data was collected.

TABLE 3-2 presents the ADD, MDD, and peaking factor data over the last four years.

TABLE 3-2 Historical Average and Maximum Day Demand

Year	ADD[a] AFY	ADD[a] gpm	MDD[b] (gpm)	MDD Peaking Factor (MDD:ADD)
2015	651	403	539	1.34
2016	557	345	591	1.71
2017	531	329	519	1.58
2018	551	342	538	1.57

[a] Includes non-revenue water use
[b] Average of three consecutive highest days

Peaking factors are typically calculated as a ratio of the demand period to ADD. For example, to determine the MDD peaking factor you would divide the MDD by the ADD. Peaking factors are used to estimate future water demands as presented and discussed in Section 3.3. To determine the existing MDD, the Waterworks Standards state the following in Section 64554(b):

> *A system shall estimate MDD and PHD for the water system as a whole (total source capacity and number of service connections) and for each pressure zone within the system (total water supply available from the water sources and interzonal transfers directly supplying the zone and number of service connections within the zone), as follows:*
>
> *(1) If daily water usage data are available, identify the day with the highest usage during the past ten years to obtain MDD; determine the average hourly flow during MDD and multiply by a peaking factor of at least 1.5 to obtain PHD.*

According to TABLE 3-2, the highest MDD during the past four years was 591 gpm, which occurred in 2016. Multiplying the MDD by a peaking factor of 1.5 results in a PHD of 887 gpm. It has been GSWC's experience that utilizing a peaking factor of 1.5 has been sufficient to meet PHD. Projected system demands for the ADD, MDD, and PHD scenarios are summarized in TABLE 3-3.

TABLE 3-3 Projected System Demands by Demand Period

Demand Period	GPM
ADD	356
MDD	591
PHD	887

3.3 Future Demand Projections

Future demands were projected first to estimate future ADD, and then peaking factors were applied to estimate MDD and PHD. The following sources of data and approaches were used:

- Growth-rate projections
- Water-demand projections

3.3.1 Growth Rate Projections

Growth rate projections were evaluated against equivalent estimates in the previous Cypress Ridge System Water Master Plan and year 2010 U.S. census data to correlate population growth with the increase in service connections. This correlation was then used to determine future water demand.

3.3.2 Water Demand Projections

The projected annual water demands were extrapolated to year 2040 to determine the projected water use. Due to ongoing groundwater basin issues in the Nipomo Mesa area and customer awareness of conservation needs, no rate of growth in overall annual water demands for the existing customer base is anticipated. However, multiple lots are projected for development once supplemental water is made available to the Nipomo Mesa (see Section 2.2.2 discussion of Purchased Water); as such, some increase in demands is expected.

FIGURE 3-2 presents the historical and projected annual water demands, including the most recent 2-year period. Projections of future demands are slightly higher than the existing demand (2019) of 574 AFY.

The State of California is in a long term drought and the Governor has issued Executive Orders that will likely result in significant reductions in future demands. This Master Plan utilizes the current requirements established by the State of California and California Public Utilities Commission in evaluating needed facilities but acknowledges that the requirements may change. Subsequent updates to this Master Plan will reflect future changes in requirements.

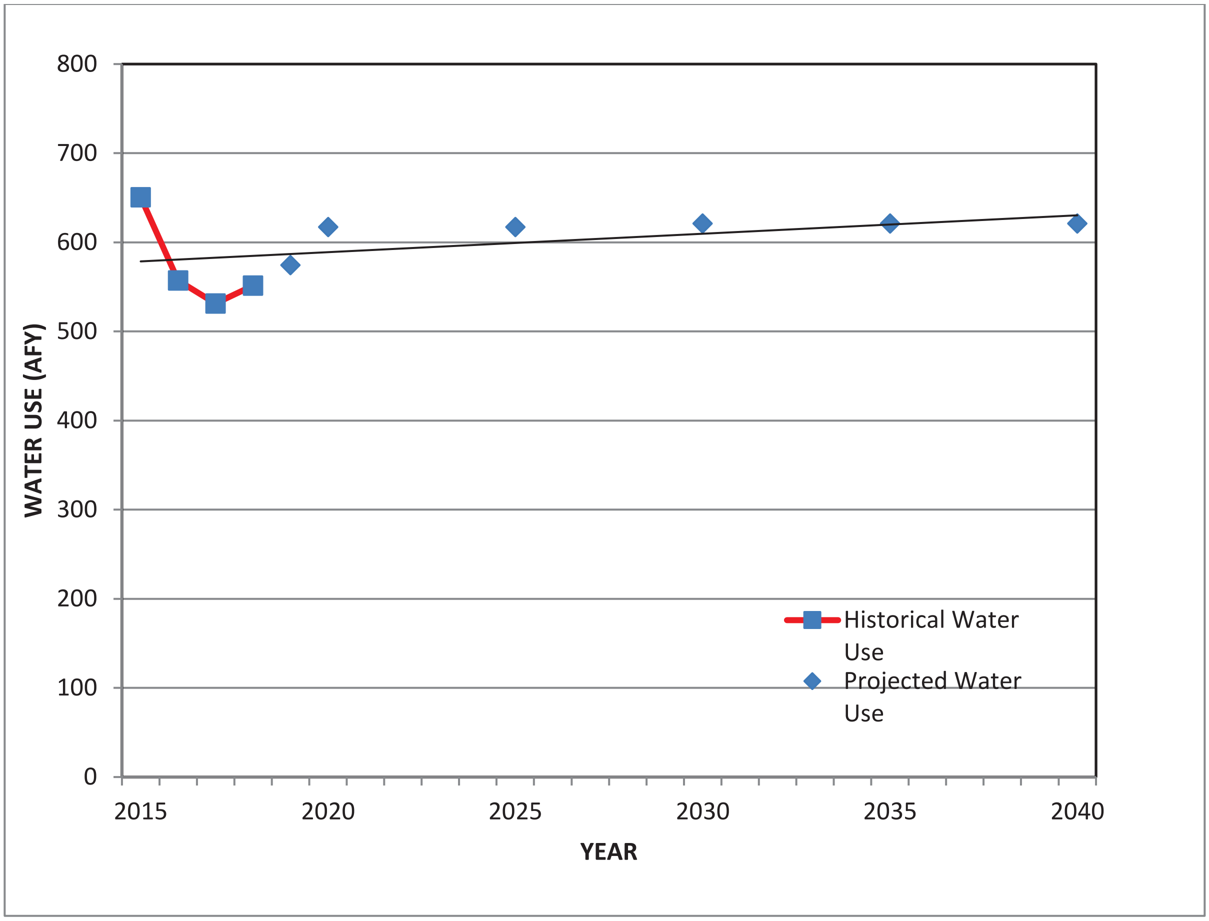


FIGURE 3-2 Historical Water Demand and Future Water Demand Projections

The water demands for 2040 project to be 621 AFY, resulting in an ADD of 385 gpm. To determine the projected MDD for year 2040, a peaking factor from TABLE 3-2 was applied to the projected ADD. The peaking factor associated with the highest MDD during the past four years, 1.71 in 2016, was selected, resulting in a MDD of 659 gpm. A peaking factor of 1.5 was multiplied by the projected MDD to determine the projected PHD, which is 988 gpm. TABLE 3-4 summarizes the projected demands for ADD, MDD, and PHD periods.

TABLE 3-4 Water System Demands by Demand Period

	Demand Period and Peaking Factor			
Planning Year	**Annual Average (AFY)**	**ADD (gpm)**	**MDD (gpm)**	**PHD (gpm)**
2019	574	356	591	887
2040	621	385	659	988

SECTION 4

Hydraulic Model Development and Calibration

4.1 Overview

A computerized hydraulic model of a water distribution system is an important tool used as part of the Water Master Plan to conduct hydraulic analyses of the water system.

The computer model is used to analyze the facilities, operational characteristics, and water supply and consumption data of a water system. The water distribution system hydraulic model includes pipes, junction nodes (connection points for pipes and location of demands), valves, wells, pumps, purchased water connections, tanks, and reservoirs. Operational characteristics include parameters that control the method by which the water is distributed through the system, such as on and off settings for pumps, pressure or flow controls for hydraulically actuated valves, or main line valve closures. Data for supply and consumption determine where the water supply and demands are applied within the modeled distribution system.

Accurate computer model development begins with entering the correct information into the data file and calibrating the model to match existing conditions in the field. Once this foundation is complete, the resulting model becomes an invaluable tool. It can simulate the existing and future water system, identify system deficiencies, analyze impacts from increased demands, and determine the effectiveness of proposed improvements.

4.2 Construction and Calibration of the Hydraulic Computer Model

A new Cypress Ridge System hydraulic model was revised as part of the 2017 Master Plan. For this Master Plan, the model was checked for accuracy and updated to include newly constructed facilities. Valve settings for pressure regulating valves were also verified, and the system demands were validated. Localized calibration was performed to refine the model in certain sections of the system.

4.3 Summary

This Master Plan update included verification of the physical components represented in the hydraulic model, validation of demands in the model, and localized field testing and calibration.

It is important to note that model calibration for any water system is an ongoing effort. As changes in the system occur from changing demands, new infrastructure development, or changing operational settings, the model must be periodically updated and checked to ensure agreement with field measurements. This update serves as a baseline for future calibration efforts by GSWC.

SECTION 5

Supply and Storage Capacity Evaluation

This section documents the evaluation of the water supply and storage capacity for the Cypress Ridge System. The evaluation results accomplished the following:

- Established storage needs for each pressure zone and the entire distribution system
- Identified supply and/or storage deficiencies in the existing and future systems
- Proposed improvements that mitigate the deficiencies identified

In each subsection, the supply and storage capacity of the existing and future water systems were measured against the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and facilities were proposed to mitigate the deficiency.

5.1 Overview

To provide a reliable water supply, a water system must be able to meet the system demands under a variety of conditions. The water supplied may be provided by a combination of supply sources, or stored water, or both. The specific demand period being analyzed may limit the source of water for the scenario. For example, stored water should not be used to meet ADD or MDD but could be used for PHD or MDD+FF. Therefore, each demand period may require a different ratio of water supplies and storage. This analysis examines various demand periods to determine if the system has the ability to reliably meet the system demands under typical demand scenarios using a combination of water supply sources and storage.

5.2 Evaluation Approach

This supply and storage capacity analysis examined the Cypress Ridge System under two planning periods:

- **Existing (2019) system.** The demands for the existing water system were determined by multiplying the four-year historical average demand per connection and the most recent number of connections (year 2018) to obtain the total system demand. The analyses assumed all facilities that were operational in 2019.

- **2040 system.** The long-term planning horizon (2040) water system analysis assumed 2040 demands (assumed buildout) and facilities included in the existing system analysis plus facilities needed to correct deficiencies in 2040.

5.2.1 Analysis Criteria

The Cypress Ridge System must be capable of providing sufficient water supply and storage capacity to meet the minimum criteria summarized in TABLE 5-1. These criteria were extracted from the technical memorandum titled *Master Planning Criteria and Standards*.

The criteria apply to the system as a whole and to each pressure zone in the system. For planning purposes, this Master Plan utilizes the Planning Scenario 'MDD + Fire Flow' to analyze the system performance under a worst-case planning scenario. The worst-case planning scenario is represented by applying the single most stringent fire flow requirement established (based on land use plans or as designated by the local fire jurisdiction) for a structure within a hydraulic zone or planning area as the baseline fire flow requirement for the entire hydraulic zone or planning area. For the purposes of the planning analysis, this is considered a goal rather than a requirement. If the result of the worst case planning scenario indicates a deficiency in MDD + Fire Flow, it should be noted that there may not be a deficiency in the actual fire flow requirement for a particular structure, but rather that GSWC is not meeting the planning goal for the overall hydraulic zone or planning area.

TABLE 5-1 Supply and Storage Capacity Analysis Criteria

Planning Scenario	Demand and Duration	Evaluation Criterion	Storage Usage	Facilities Assumed to be Out of Service
Average day	ADD for 24 hours	Total capacity	No storage drawdown	-
Maximum day	MDD for 24 hours	Firm capacity	No storage drawdown	Largest pumping unit in system
Peak hour	PHD for 4 hours[1]	Firm capacity	Operational storage	Largest pumping unit in system
MDD + fire flow	MDD plus fire flow, duration varies[2]	Total capacity	Fire storage	-

[1] Operational storage required to meet peak demands during MDD was defined as the supply needs during 4 hours of PHD.
[2] Fire flow scenarios are based on fire agency maximum flow requirements for a single structure within a planning area and are applied throughout the planning area as part of the planning analysis. Actual fire flows may be less than the maximum fire flow used for planning analysis.

It is worth noting that the California Public Utilities Commission (CPUC) and State Water Resources Control Board, Division of Drinking Water (DDW) currently provide no specific requirements for storage volume. Therefore, recommended standards published by the American Water Works Association (AWWA) were considered in the development of the storage criteria used in this master plan.

5.2.2 Storage

In addition to providing adequate water supplies for the water consumers, water distribution systems often rely on stored water within the distribution system to provide the following operational benefits:

- Help equalize fluctuations between supply and demand.
- Supply sufficient water for firefighting.
- Meet demands during an emergency or unplanned outage of a major supply source.

AWWA defines three types of storage: operational, fire, and emergency. The amount of storage required for each of these types varies by system. Nevertheless, all three types of storage must be considered. In some cases, water stored in the groundwater basin can provide some of this storage. However, when the stored water does not flow by gravity and requires pumping, sufficient pumping redundancy and stand-by power generators must be provided if the storage source is to be considered reliable.

This analysis evaluates the ability of the system's storage facilities to meet the water system's storage requirements. The resulting volume must be allocated to the pressure zones where the demands exist, or to a neighboring zone (if there are pressure-regulating stations or check valves available that allow the water to flow into the neighboring zone). The water system must also be evaluated to determine if existing booster stations provide sufficient water to be pumped into the higher-pressure zones.

TABLE 5-2 presents the recommended operational, fire, and emergency storage criteria as defined by GSWC for the Cypress Ridge System.

TABLE 5-2 Criteria for Calculating Storage

Storage Category	GSWC Criteria
Operational	Storage volume to meet PHD in addition to MDD supply
Fire	Maximum recommended fire storage volume in the system
Emergency	ADD for 12 hours

Operational Storage

The required volume of water for operational storage is determined by the volume needed for regulating the difference between the rate of supply and the daily variations (peaks) in water usage. This difference results in the lowest and highest operating levels in the reservoirs under normal conditions. The resulting volume must be allocated to either the pressure zone (where the demands exist) or to a higher-pressure zone (for use by the lower-pressure zone).

Fire Storage

The volume of water required for firefighting is a function of the instantaneous flow rate required to fight the fire over the duration of the fire flow event as determined by the local fire jurisdiction. Consideration is also made to evaluate the number of fire flow events that may occur before the volume can be replenished. Further, the volume of water necessary to fight a fire can be provided from water supply, water storage, or a combination thereof. For planning purposes, it is desirable and conservative to design the water system to have capacity within water tanks for the volume of water needed for firefighting; however, the fire storage in the tanks plus available supply in excess of MDD can be utilized to meet firefighting requirements. The fire-flow requirements listed in TABLE 5-3 were used to establish the flow rate and duration for each pressure zone; these criteria were used to identify the largest volume of water required for firefighting within each pressure zone (based on the land use in that zone and the flow rates and durations from TABLE 5-3). The resulting fire-flow volumes are shown in TABLE 5-3.

TABLE 5-3 Fire Storage Volumes

Land Use Category	Minimum Fire Flow Required (gpm)	Duration (hr)	Recommended Fire Storage Volume (MG)
Residential	750	2	0.09
School	1,500	2	0.18

MG: million gallons

For the Cypress Ridge System, it was assumed that only one fire event within the system would occur before storage tanks could recover. The lowest fire-flow volume (0.09 MG) is the result of a 750-gpm fire for the duration of 2 hours (single-family residential land use). The largest fire-flow volume (0.18 MG) is the result of a 1,500-gpm fire for the duration of 2 hours (school).

Emergency Storage

Emergency storage is a dedicated source of water that can be used as a backup supply in the event a major supply source is interrupted. This can be provided by water from a second independent source, by water stored in reservoirs, or a combination of both. *Ten States Standards* recommends that emergency storage total between 12 and 24 hours of ADD volume. Because the Cypress Ridge System contains multiple supply sources and storage reservoirs, 12 hours of ADD volume for this system is appropriate.

5.3 Existing System Evaluation

Evaluation of the existing system's supply and storage capacity involved analysis of key system facilities to identify supply or storage capacity deficiencies. This approach involved analyzing multiple proposed improvement alternatives to address these deficiencies. These proposed improvements were then evaluated to determine the most cost-effective alternatives, which would then be identified as the recommended improvements and incorporated into the CIP. The following subsections describe the existing system evaluation:

- Water demands for each demand period
- Supply facilities
- Storage facilities
- Capacity analysis
- Proposed improvements to address deficiencies in the existing system

5.3.1 Existing System Water Demands for Each Demand Period

TABLE 5-4 defines the existing demands by pressure zone for each demand period, based on spatial demand allocation from the Cypress Ridge GIS.

TABLE 5-4 Existing System Water Demands

Pressure Zone	ADD (gpm)	MDD (gpm)	PHD (gpm)	Demand by Zone (%)
Main Zone	225	374	561	63
Cypress Ridge Zone	100	165	248	28
Indian Hills Zone	31	52	78	9
Total	**356**	**591**	**887**	**100**

5.3.2 Existing System Supply Facilities

The existing water supply facilities in the Cypress Ridge System were identified in Section 2, Existing Water System Facilities. TABLE 5-5 summarizes the design production capacity of each supply source and systemwide totals for total capacity and firm capacity.

TABLE 5-5 Existing System Supply Facilities

Facility Name	Source	Pressure Zone	Total Capacity (gpm)
Cypress Ridge #4 (Club House Plant)	Groundwater	Cypress Ridge Zone	125
Cypress Ridge #5 (Auklet Plant)	Groundwater	Cypress Ridge Zone	60
Cypress Ridge #6 (Wigeon Plant)	Groundwater	Cypress Ridge Zone	125
Cypress Ridge #7 (Brant Plant)	Groundwater	Cypress Ridge Zone	70
Cypress Ridge Zone Total			**380**
El Campo #2	Groundwater	Main Zone	120
El Campo #6	Groundwater	Main Zone	100
Fowler #3	Groundwater	Main Zone	270
Ridgemont #4	Groundwater	Main Zone	160
Ridgemont #7	Groundwater	Main Zone	110
Main Zone Total			**760**
Systemwide Total			**1,140**

5.3.3 Existing System Storage Facilities

The existing storage facilities in the Cypress Ridge System are described in Section 2, Existing Water System Facilities. TABLE 5-6 summarizes the storage facilities for the Cypress Ridge System.

TABLE 5-6 Existing System Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Cypress Ridge 1 (North)	Cypress Ridge Zone	0.275
Cypress Ridge 2 (South)	Cypress Ridge Zone	0.275
Cypress Ridge Zone Total		**0.55**
El Campo 1 (Northeast)	Main Zone	0.20
El Campo 2 (Southwest)	Main Zone	0.22
Falcon Crest	Main Zone	0.212
Main Zone Total		**0.632**
Total storage capacity		**1.182**

5.3.4 Existing System Supply and Capacity Analysis

This analysis of the existing water distribution system evaluated the Main Zone, Cypress Ridge Zone, and Indian Hills Zone separately and then the system as a whole to verify that adequate supply and storage facilities were available. The analysis reviewed the demand periods (ADD, MDD, PHD, and MDD+FF); the duration for each demand period is detailed in TABLE 5-1. The duration of MDD+FF was established by the fire-flow criteria identified in TABLE 5-3.

The demands and production capacities for each zone are presented in a table that summarizes the results. These tables present the demands for each demand period in the zone and for any zones that depend on this zone for supplies. These demands are presented as a flow rate and are converted into a demand volume using the duration for the demand period. For example, a demand of 100 gpm for ADD would be equal to a demand volume of 144,000 gallons, given that the duration of ADD is 24 hours.

Available supplies are presented below the demand volume totals. Available supplies include water supply sources, booster pumping capacity, and stored water. Stored water was not used to provide water supplies during ADD or MDD. Stored water that was allocated as operational storage was assumed to be available for PHD, and water stored for fire flows was assumed to be available for MDD+FF. The total supplies were assumed to be available for ADD and MDD+FF. For the purpose of assuring reliable water service is provided to customers, each zone's ability to meet MDD and PHD with firm capacity was analyzed. (Firm capacity was defined as the available capacity with the largest pumping unit out of service.) The available production was calculated by converting flow rates into a production volume (using the duration of the demand period) and adding the available storage volume.

The last two lines of the table compare the system's available production capacity to the demands for the same duration. Where production capacity exceeds demands, the row *supply minus demand* will be positive. This indicates an adequate combination of supplies and storage. Where this occurs, the last row of the table, *supply meets demand*, will contain *yes*. However, if demands exceed production, then the row *supply minus demand* will have a negative value, and the row *supply meets demand* will contain *no*. In this latter case, proposed improvements were evaluated to correct the deficiency.

Main Zone Analysis

Water supply to the Main Zone is provided by five active wells, as listed in TABLE 5-5, and five boosters, as listed in TABLE 2-7. All of the wells except for Fowler Well #3 pump into the El Campo Reservoirs. There is 0.632 MG storage in this pressure zone. Fire flow was assumed to occur at only one place at a given time, and the maximum fire flow (0.18 MG) was assumed.

The overall capacity analysis for the Main Zone is presented in TABLE 5-7.

TABLE 5-7 Existing System Supply and Capacity Analysis—Main Zone

		Planning Scenario							
		ADD		**MDD**		**PHD**		**MDD+FF**	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Main		225	0.324	374	0.538	561	0.135	1,874	0.225
Indian Hills Zone	BP	31	0.045	52	0.075	78	0.019	52	0.006
Total Demand		**256**	**0.369**	**426**	**0.613**	**639**	**0.153**	**1,926**	**0.231**
Supply	Capacity								
Wells (GPM)	270	270	0.389	0	0.000	0	0.000	270	0.032
Boosters (GPM)	882	490	0.706	490	0.706	882	0.212	882	0.106
Reservoirs (MG)	0.21	-	-	-	-	174	0.042	464	0.056
Total Supply		**760**	**1.094**	**490**	**0.706**	**1,056**	**0.253**	**1,616**	**0.194**
Supply Minus Demand		**504**	**0.725**	**64**	**0.092**	**417**	**0.100**	**-310**	**-0.037**
Supply Meets Demand		**YES**		**YES**		**YES**		**NO**	

*The available storage from El Campo Reservoirs #1 and #2 – and the supply capacity from El Campo Wells #2 and #6, and Ridgemont Wells #4 and #7 – is limited by the booster capacity of the El Campo Plant, as the four wells pump into the El Campo Reservoirs and the water is then re-boosted before entering the distribution system. For the purpose of this analysis, the well "pass through" capacity at the El Campo Plant was used for the ADD and MDD scenario (no storage drawdown); the only reservoir supply capacity directly available to the Main Zone is from the Falcon Crest Reservoir. The supply capacity of the wells, the operational storage capacity from El Campo Reservoirs #1 and #2 and the storage capacity from Falcon Crest Reservoir are available for the PHD scenario, and the wells, Falcon Crest Reservoir, and fire storage from the El Campo Reservoirs are available for the MDD+FF scenario.

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios except for MDD+FF. However, for the MDD+FF scenario, the fire flow deficiency shown above can be met by additional supply from the El Campo Reservoir via Booster E (operational, but no pump/curve data available) or lower-pressure supply from the Falcon Crest Reservoir (system pressure of 20 psi allowed under fire flow conditions); the system storage analysis in TABLE 5-12 indicates no storage deficiency.

Cypress Ridge Zone Analysis

Water supply to the Cypress Ridge Zone is provided by four active wells, as listed in TABLE 5-5, and three boosters, as listed in TABLE 2-7. All of the wells pump into the Cypress Ridge Reservoirs. There is 0.55 MG storage in this pressure zone. Fire flow was assumed to occur at only one place at a given time, and the minimum fire flow (0.09 MG) was assumed.

The overall capacity analysis for the Cypress Ridge Zone is presented in TABLE 5-8.

TABLE 5-8 Existing System Supply and Capacity Analysis—Cypress Ridge Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Cypress Ridge Zone		100	0.143	165	0.238	248	0.060	915	0.110
Total Demand		**100**	**0.143**	**165**	**0.238**	**248**	**0.060**	**915**	**0.110**
Supply	Capacity								
Boosters (GPM)	2,650	380	0.547	255	0.367	373	0.090	1,040	0.125
Total Supply		**380**	**0.547**	**255**	**0.367**	**373**	**0.090**	**1,040**	**0.125**
Supply Minus Demand		**280**	**0.404**	**90**	**0.129**	**125**	**0.030**	**125**	**0.015**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

*The available storage from Cypress Ridge Reservoirs #1 and #2 – and the supply capacity from Cypress Ridge Wells #4, #5, #6 and #7 – is limited by the booster capacity of the Cypress Ridge Plant, as the four wells pump into the Cypress Ridge Reservoirs and the water is then re-boosted before entering the distribution system. For the purpose of this analysis, the well "pass through" capacity at the Cypress Ridge Plant was used for the ADD scenario (no storage drawdown), and the well firm capacity was used for the MDD scenario. The Cypress Ridge booster firm capacity was used for the PHD scenario.

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios.

Indian Hills Zone Analysis

Water supply to the Indian Hills Zone is provided by four boosters from the Main Zone. There is no storage in this pressure zone. Fire flow was assumed to occur at only one place at a given time, and the minimum fire flow (0.09 MG) was assumed.

The overall capacity analysis for the Indian Hills Zone is presented in TABLE 5-9.

TABLE 5-9 Existing System Supply and Capacity Analysis—Indian Hills Zone

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Indian Hills Zone		31	0.045	52	0.075	78	0.019	802	0.096
Total Demand		**31**	**0.045**	**52**	**0.075**	**78**	**0.019**	**802**	**0.096**
Supply	Capacity								
Boosters (GPM)	353	31	0.045	52	0.075	78	0.019	353	0.042
Total Supply		**31**	**0.045**	**52**	**0.075**	**78**	**0.019**	**353**	**0.042**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**-449**	**-0.054**
Supply Meets Demand		**YES**		**YES**		**YES**		**NO**	

The existing system supply and storage capacity analysis results indicate that facilities are adequate to meet the demands for all planning scenarios except for MDD+FF. Proposed improvements to overcome these deficiencies are described in Section 5.3.6.

Systemwide Capacity Analysis

In the systemwide analysis, all supply and storage facilities were included. The total existing demands were presented in TABLE 5-4. The total and firm production capacities in TABLE 5-5 and the storage facilities in TABLE 5-6 were used for the appropriate demand periods. The fire flow used for MDD+FF was based on the largest fire flow in the system, a 1,500-gpm fire flow for 2-hour duration.

The results of the systemwide supply and storage analysis for the existing system are summarized in TABLE 5-10.

TABLE 5-10 Existing System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		**MDD**		**PHD**		**MDD+FF**	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**356**	**0.513**	**591**	**0.851**	**887**	**0.213**	**2,091**	**0.251**
Supply	Capacity								
Wells (GPM)	270	256	0.369	0	0.000	0	0.000	270	0.032
Boosters (GPM)	3,532	100	0.144	591	0.851	713	0.171	630	0.076
Reservoirs (MG)	0.21	-	-	-	-	174	0.042	1,191	0.143
Total Supply		**356**	**0.513**	**591**	**0.851**	**887**	**0.213**	**2,091**	**0.251**
Supply Minus Demand		**0**	**0.000**	**0**	**0.000**	**0**	**0.000**	**0**	**0.000**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

The systemwide supply and storage analysis results for the existing system indicate that the existing supply meets the demands for all planning scenarios.

5.3.5 Existing System Storage Analysis

The analysis of the existing storage facilities evaluated the required storage for each pressure zone and compared it to the existing storage available for each zone to determine the storage deficiencies. The benefits of storage and the types of storage (operational, fire, and emergency) are described in more detail in section 5.2.2.

TABLE 5-11 evaluates the three types of storage to calculate the total required storage for each zone and the entire system. The operational storage is calculated by subtracting the MDD from the PHD to obtain the additional flowrate that is required during the PHD scenario. This additional flowrate is multiplied by the duration of PHD and then converted to a volume to determine the required operational storage. A duration of four hours was used to account for the typical duration of peak demands during the day. The fire storage for each zone is based on criteria given in section 5.2.2. In cases where two or more pressure zones retain their fire storage in the same reservoir, that reservoir only needs to contain the fire storage for the zone with the largest recommended fire storage volume. This is because the criteria consider only one fire flow can occur in the system at any given time. To prevent accounting for excess fire storage, pressure zones were given a fire storage total of 0 MG in TABLE 5-11 when fire storage of larger or equal size was used in another zone that retains its fire storage in the same tank. The emergency storage is the volumetric measurement of the ADD over a duration of 12 hours.

Storage deficiencies are identified for each zone in TABLE 5-12. All tanks in the existing system are listed in the left column of the table. All pressure zones in the existing system are listed in the top row of the table. The numbers in the table represent the allotted amount of storage, in millions of gallons, for each zone from each tank. A dash in the table denotes storage from that tank is unavailable for that zone. Zones that are able to utilize storage in a tank, but are not allotted any storage from it are shown in the table as zero. Summing the numbers across the rows results in the total storage volume of the tank listed in the left column of that row. Summing the numbers going down the columns results in the available storage for the zone listed in the top row of that column. The required storage, taken from TABLE 5-10, is given in the row below the available storage. Subtracting the required storage from the available storage within a column results in the excess storage for that column's zone. Negative numbers imply a storage deficiency and are given a "NO" in the adequate storage column. A "YES" in the adequate storage column implies there is adequate storage available for that zone. Fire storage is calculated to supplement supply when the supply is less than the current demand plus fire flow (see Section 5.3.4). Fire storage requirements are planning standards and fire storage is typically only required in times of high demands, supply limitations, and/or emergencies.

TABLE 5-11 Existing System Storage Analysis - Calculated Storage

	Zones			
	Main Zone	**Cypress Ridge Zone**	**Indian Hills Zone**	**Systemwide**
Operational				
PHD	561	248	78	887
MDD	374	165	52	591
PHD minus MDD	187	83	26	296
Duration	4	4	4	4
MG	0.045	0.020	0.006	0.071
Fire				
GPM	1500	750	750	-
Duration	2	2	2	-
MG*	0.180	0.090	0.000	0.270
Emergency				
ADD	225	100	31	356
Duration	12	12	12	12
MG	0.162	0.072	0.022	0.256
Total Recommended Storage	**0.387**	**0.182**	**0.029**	**0.597**

* A fire storage total of zero indicates that fire storage of larger or equal size was used in another zone that receives its fire storage from the same tank.
NOTE: All demand period scenarios (ADD, MDD, and PHD) are given in gallons per minute (GPM). All durations are given in hours. The rows titled "MG" and the total required storage are given in million gallons (MG)

TABLE 5-12 Existing System Storage Analysis - Adequacy Evaluation

	Zones			
	Main Zone	Cypress Ridge Zone	Indian Hills Zone	Total
Cypress Ridge Tank 1 (North)	-	0.275	-	0.275
Cypress Ridge Tank 2 (South)	-	0.275	-	0.275
El Campo Tank 1 (Northeast)	0.200	-	-	0.200
El Campo Tank 2 (Southwest)	0.220	-	-	0.220
Falcon Crest Tank	0.183	-	0.029	0.212
Available Storage	0.603	0.550	0.029	1.182
Recommended Storage*	0.387	0.182	0.029	0.597
Available Minus Recommended	0.216	0.368	0.000	0.585
Adequate Storage	**YES**	**YES**	**YES**	**YES**

The existing system storage analysis results indicate no storage deficiency.

5.3.6 Proposed Improvements to Address Deficiencies in the Existing System

Various alternatives were considered while investigating improvements to correct the deficiencies identified in the supply and storage evaluation; these are listed in TABLE 5-13. Deficiencies may be corrected by adding supply, storage, or a combination of both. In these cases, the deficiency is shown in both supply (gpm) and storage (MG). The descriptions of the deficiency alternatives are given at the end of TABLE 5-13.

The only deficiency identified in the supply and storage evaluation was a supply and storage analysis deficiency of:

- 449 gpm (0.054 MG) for MDD+FF (Indian Hills Zone)

The numbering system used in TABLE 5-13 is a series of three numbers. The first number indicates the planning period: 1 for the existing system and 2 for the 2040 system. The second number indicates the deficiency number, which starts at 1 and increments by 1 for each deficiency identified. The third number identifies the improvement alternative, but zero is reserved for the deficiency. Therefore, the alternative number 1.2.3 would be used to identify the third proposed alternative for the second deficiency in the existing system.

TABLE 5-13 Existing System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
1.1.0	**Inadequate Supply for MDD+FF**	**Indian Hills Zone**	449	0.054

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
1.1.1	Increase storage capacity	Indian Hills Zone		0.054
1.1.2	Increase supply capacity	Indian Hills Zone	449	
1.1.3	Install check valve	Indian Hills Zone	449	

Descriptions of Deficiency Alternatives

Deficiency No. 1.1.0

Alternative No. 1.1.1

This alternative proposes to construct a 0.054 MG reservoir in the Indian Hills Zone, at a site to be determined.

Alternative No. 1.1.2

This alternative proposes to increase the supply capacity to the Indian Hills Zone by an additional 449 gpm. Adding a booster pump could resolve this deficiency.

Alternative No. 1.1.3

This alternative proposes to install a dual-flow PRV/check valve from the Main Zone to the Indian Hills Zone to increase the supply to the Indian Hills Zone during low pressure scenarios such as MDD + FF. Replacing the existing Sevada Lane PRV with a dual-flow valve could help to reduce this deficiency.

5.3.7 Recommended Improvements to Address Deficiencies in the Existing System

Recommended improvements to resolve the deficiencies in the existing system are given in TABLE 5-14. These proposed improvements were recommended for their ability to correct the deficiency and be cost-effective compared to competing alternatives. Refer to the 'Descriptions of Deficiency Alternatives' in section 5.3.6 for more detailed descriptions of proposed improvements. In some cases, the capacity of the proposed improvement is larger than described in the 'Descriptions of Deficiency Alternatives'. This was necessary in order to resolve multiple deficiencies.

TABLE 5-14 Existing System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
1.1.3	Replace the Sevada Lane PRV with a dual-flow PRV/check valve	1.1.0	449 gpm

5.4 2040 System Evaluation

Analysis of the water system for the year 2040 was performed to identify long-term improvements needed for the water system at buildout. This analysis included the following assumptions:

- Existing supply sources would remain active or be replaced in kind.
- Planned improvements to address existing system deficiencies plus the post-2017 improvements are operational.
- The demands developed in Section 3, Existing and Future Water Demands, were assumed for the respective demand periods.

5.4.1 2040 System Water Demands for Each Demand Period

TABLE 5-15 defines the 2040 demands for the Cypress Ridge System. The demands are not provided for each pressure zone because it is unknown how much each zone's demands will increase by the year 2040.

TABLE 5-15 2040 System Water Demands

	ADD (gpm)	MDD (gpm)	PHD (gpm)
Systemwide	385	659	988

5.4.2 2040 System Supply Facilities

The supply facilities for the 2040 system include all supply facilities in the existing system along with all recommended supply facilities to resolve the existing system's deficiencies. TABLE 5-16 summarizes the supply for the 2040 System.

TABLE 5-16 2040 System Assumed Supply Facilities

Facility Name	Total Capacity (gpm)
Additional facilities in the 2040 System	129[a]
Existing supply – Wells	1,615[b]
Total production capacity for 2040	**1,744**

[a] Assume supplemental water availability of approximately 208 AFY (8.33% of 2,500 AFY), via Interconnection with NCSD (see Section 2.2.2 discussion of Purchased Water).
[b] 1,140 gpm current well capacity (per Table 5-5), plus 475 gpm capacity – Lopez High Wells #8 and #9 – brought back online via nitrate treatment (project 1.6.1, Table 7-2) or replaced in-kind.

5.4.3 2040 System Storage Facilities

The storage facilities for the 2040 system include all storage facilities in the existing system along with all recommended storage facilities to resolve the existing system's deficiencies. TABLE 5-17 summarizes the storage for the 2040 System.

TABLE 5-17 2040 System Assumed Storage Facilities

Facility Name	Primary Pressure Zone Served	Total Capacity (MG)
Recommended storage facilities	Main	0
Existing storage	Systemwide	1.182
Total storage capacity		**1.182**

5.4.4 2040 System Capacity Analysis

The supply analysis for the 2040 system uses the 2040 projected demands and includes the recommended 2040 supply improvements to analyze system deficiencies. An analysis is not given for each pressure zone because it is unknown how much each zone's demands will increase by year 2040. The supply analysis is given in TABLE 5-18.

TABLE 5-18 2040 System Supply and Capacity Analysis—Systemwide

		Planning Scenario							
		ADD		MDD		PHD		MDD+FF	
Duration (Hours)		24		24		4		2	
Demand		GPM	MG	GPM	MG	GPM	MG	GPM	MG
Total Demand		**385**	**0.555**	**659**	**0.948**	**988**	**0.237**	**2,159**	**0.259**
Supply	Capacity								
Boosters (GPM)	3,532	1,744	2.511	1,444	2.079	1,444	0.347	1,744	0.209
Reservoirs (MG)	0.21	-	-	-	-	0	0.000	430	0.052
Total Supply		**1,744**	**2.511**	**1,444**	**2.079**	**1,444**	**0.347**	**2,174**	**0.261**
Supply Minus Demand		**1,359**	**1.957**	**785**	**1.131**	**456**	**0.109**	**15**	**0.002**
Supply Meets Demand		**YES**		**YES**		**YES**		**YES**	

*With proposed nitrate treatment (project 1.6.1, Table 7-2) improvements, it is assumed that all wells – in addition to the Interconnection with NCSD – will first go into the El Campo and/or Cypress Ridge Reservoirs and then be re-boosted before entering the distribution system. For the purpose of this analysis, the well "pass through" capacity at the El Campo and Cypress Ridge Plants was used for the ADD and MDD scenario (no storage drawdown), with the largest well capacity (300 gpm Lopez High #8) assumed out of service for the MDD scenario.

The systemwide supply and storage analysis results for the 2040 system indicate that the supply meets the demands for all planning scenarios.

5.4.5 2040 System Storage Analysis

The storage analysis for the 2040 system uses the 2040 projected demands and includes the recommended supply and storage improvements for the existing system to analyze system deficiencies. Like the 2040 supply analysis, each pressure zone is not analyzed because it is unknown how much each zone's demands will increase by year 2040. The storage analysis is given in TABLE 5-19.

TABLE 5-19 2040 System Storage Analysis

Scenario		Systemwide
Operational	PHD	988
	MDD	659

	PHD minus MDD	329
	Duration	4
	MG	0.079
Fire	GPM	1,500
	Duration	2
	MG*	0.180
Emergency	ADD	385
	Duration	12
	MG	0.277
Total Recommended Storage		0.536
Available Storage in 2040		1.182
Available minus Recommended		0.646
Adequate Storage		YES

The 2040 system storage analysis results indicate no deficiency.

5.4.6 Proposed Improvements to Address Deficiencies in the 2040 System

The 2040 system analysis results indicate no deficiencies.

TABLE 5-20 2040 System Proposed Supply and Storage Improvements

Deficiency/ Alternative Number	Deficiency/Alternative Description	Pressure Zone	Supply Capacity (gpm)	Storage Capacity (MG)
-	-	-	-	-

5.4.7 Recommended Improvements to Address Deficiencies in the 2040 System

Recommended improvements to resolve the deficiencies in the 2040 system are given in TABLE 5-21. These proposed improvements were recommended for their ability to correct the deficiency and be cost-effective compared to competing alternatives. Refer to the 'Descriptions of Deficiency Alternatives' in section 5.4.6 for more detailed descriptions of proposed improvements. In some cases, the capacity of the proposed improvement is larger than described in the 'Descriptions of Deficiency Alternatives'. This was necessary in order to resolve multiple deficiencies.

TABLE 5-21 2040 System Recommended Supply and Storage Improvements

Alternative Number	Alternative Description	Deficiencies Resolved	Supply/Storage Capacity
-	-	-	-

5.5 Summary of Proposed Supply and Storage Improvements through 2040

According to the supply and capacity analysis results in this Master Plan, the following additional supply is necessary to meet future demands:

- Existing system: 449 gpm (Indian Hills Zone) of additional supply
- 2040 system: no additional supply

Installation of a dual-flow PRV/check valve from the Main Zone to the Indian Hills Zone is recommended in order to reduce the deficiencies of the existing system.

According to the storage analysis results in this Master Plan, the following additional storage is necessary to meet future demands:

- Existing system: no additional storage
- 2040 system: no additional storage

Note: The Cypress Ridge Zone and Main Zone were analyzed separately in this Master Plan, however Operations should consider combining the Main Zone and Cypress Ridge Zone, which are already similar in HGL, to improve supply redundancy. Replacement of the single normally-closed valve (across from the El Campo Plant) with a PRV and/or installation of a second pipeline/connection at either Cypress Ridge Parkway or Brant St/Willet Way would effectively combine the zones (see Condition Assessment Project 1.18.0, TABLE 8-2).

The supply and storage improvements planned by GSWC and analyzed in these evaluations are further examined in Section 6, Hydraulic Analysis and Evaluation. The hydraulic analysis helps determine the optimal configuration of improvements to provide maximum operational and cost benefit, and any resulting recommended improvements are incorporated into the CIP.

SECTION 6

Hydraulic Analysis and Evaluation

This section documents the hydraulic analysis and evaluation results for the Cypress Ridge System. The hydraulic analysis used the calibrated computer model to evaluate the existing water system. This analysis and evaluation accomplished the following tasks:

- Summarized the criteria for the hydraulic analysis
- Performed simulations for various demand conditions and demand periods
- Analyzed the modeling results to identify deficiencies
- Analyzed various proposed improvements to investigate ways to mitigate these deficiencies
- Developed a list of recommended improvements that provide a cost-effective means to correct deficiencies

In following sections, the hydraulic analysis results of the existing water system were compared with the objectives identified in the technical memorandum titled *Master Planning Criteria and Standards* (see Appendices). When the analysis indicated that the system did not meet these criteria, a deficiency was identified and improvements were proposed to mitigate the deficiency.

6.1 Overview

Hydraulic analyses of networked water distribution systems are most efficiently performed with the aid of hydraulic computer models and specialized software that perform the numerical analysis. The hydraulic computer model assists with measuring system performance, analyzing operational improvements, and developing a systematic method of determining the size and timing required for new facilities. The model can be used to analyze existing water systems, future water systems, and the effect of specific improvements. By analyzing numerous planning scenarios relatively quickly and easily, the model provides answers to several "what if" questions. The computer program analyzes all of the information in the system data file and generates results in terms of pressures, flow rates, and operating status. The key to successfully using the computer model is correct interpretation of these results, and understanding how the water distribution system was affected.

6.2 Analysis Approach

This hydraulic analysis examined the Cypress Ridge System for only one planning period:

- **Existing (2019) system.** The existing water system analyses assumed 2019 demands, as described in Section 3, and facilities that were operational in 2019.

The demands used in this hydraulic analysis are the same as used for the supply and storage capacity analysis in Section 5.

6.2.1 System Performance Criteria

Hydraulic analysis of the water system involved the use of a computer model that was developed specifically for the Cypress Ridge System and calibrated to conditions observed in the field (see Section 4, Hydraulic Model Development and Calibration). This computer model was used to identify hydraulic deficiencies under the existing planning scenario. Hydraulic model simulations were developed to analyze demand periods (ADD, MDD, PHD, and MDD+FF) to determine whether the system could meet the performance objectives identified for this master plan. These criteria are summarized in TABLE 6-1.

TABLE 6-1 Hydraulic Analysis Criteria

Demand Period	Pipeline Criteria[a]	Pressure Criteria[b]
ADD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
MDD	Velocity less than 5 fps and head loss less than 6 ft per 1,000 ft	Greater than 40 psi and less than 125 psi
PHD	Velocity less than 10 fps	Greater than 30 psi and less than 125 psi
MDD + fire flow	Velocity less than 10 fps	Greater than 20 psi

[a] If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement due to hydraulic deficiencies alone.
[b] Pressure criteria apply only at service connections.

6.2.2 Fire-flow Requirements

In addition to providing adequate water supply and pressure to serve residential, commercial, and industrial water demands placed on the system, the water system must also deliver an adequate supply for firefighting. Since fires can occur at any time, the water system must be ready to provide the required flow at all times with an adequate residual pressure. The water system should be capable of providing the fire flows during an MDD period (MDD+FF), which represents the day of the year having the highest water demands.

To determine the system's capacity to provide adequate fire flows, it was necessary to establish minimum fire-flow demand requirements to be applied to various locations throughout the distribution system, as well as a minimum residual pressure (the pressure near the flowing hydrant) and system pressure. The local agency responsible for establishing fire-flow requirements for the Cypress Ridge System service area is CDF/Cal Fire, which provides fire protection services for the unincorporated areas of San Luis Obispo County. Their fire code regulations were used as a guide to develop the fire-flow criteria established for this master plan, which were presented in the previous section in TABLE 5-3.

6.3 Existing System Hydraulic Analysis

Several hydraulic computer model simulations were conducted for the existing distribution system to identify system and operational deficiencies, and to evaluate system improvements to mitigate these deficiencies. If more than one alternative was possible to mitigate a deficiency, the most cost-effective and constructible improvement was recommended.

6.3.1 Operational Assumptions

GSWC operations staff provided information on how the Cypress Ridge System would normally be operated under ADD, MDD, and PHD periods. Based on this information, the facilities available for the hydraulic analysis of the existing system are presented in TABLE 6-2. (Note: The status of wells, MWD connections, booster pumps and storage tanks were not based on the model results, but on the amount of supply needed for each demand period. For ADD, there is flexibility to operate various combinations of wells, as not all of the wells need to be operational to achieve the desired pressures; for MDD and PHD scenarios, firm capacity must be used.)

TABLE 6-2 Existing System Operating Facility Status

Facility Name	ADD	MDD	PHD
Wells—Main Zone			
El Campo #2	Available	On	On
El Campo #6	Available	On	On
Fowler #3	Available	Off	Off
Ridgemont #4	Available	On	On
Ridgemont #7	Available	On	On
Wells—Cypress Ridge Zone			
Cypress Ridge #4	Off	Off	Off
Cypress Ridge #5	Available	On	On
Cypress Ridge #6	Available	On	On
Cypress Ridge #7	Available	On	On
Booster pumps—Main Zone			
El Campo Booster A	Available	Available	Available
El Campo Booster B	Available	Available	On
El Campo Booster C	Available	On	On
El Campo Booster D	Off	Off	Off
El Campo Booster E	Off	Off	Off
Falcon Crest Booster A	Off	Off	On
Falcon Crest Booster B	Off	Off	Available
Falcon Crest Booster C	Off	Off	Available
Booster pumps—Cypress Ridge Zone			
Cypress Ridge Booster A	Available	On	On
Cypress Ridge Booster B	Available	On	On
Cypress Ridge Booster C	Available	Available	Available

Facility Name	ADD	MDD	PHD
Cypress Ridge Booster D	Off	Off	Off
Booster pumps—Indian Hills Zone			
Indian Hills Booster A	Available	Available	Available
Indian Hills Booster B	Available	Available	Available
Indian Hills Booster C	Available	On	On
Indian Hills Booster D	Available	Available	Available
Storage tanks—Main Zone			
El Campo 1	75%	75%	75%
El Campo 2	75%	75%	75%
Falcon Crest	75%	75%	75%
Storage tanks—Cypress Ridge Zone			
Cypress Ridge 1	75%	75%	75%
Cypress Ridge 2	75%	75%	75%

6.3.2 Average Day Scenario Analysis

To analyze the average day scenario for the existing system, simulations were performed using the computer model with ADD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 356 gpm. Only the facilities listed as 'Available' in TABLE 6-2 were used for ADD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.3 Maximum Day Scenario Analysis

To analyze the maximum day scenario for the existing system, simulations were performed using the computer model with MDD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 591 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for MDD. (Note: Storage should not be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.4 Peak Hour Scenario Analysis

To analyze the peak hour scenario for the existing system, simulations were performed using the computer model with PHD. The demands were distributed in the model per TABLE 5-4, for a total demand of approximately 887 gpm. Only the facilities listed as 'On' in TABLE 6-2 were used for PHD. (Note: Storage may be drawn down for this planning scenario.) The modeling results were compared to the criteria identified in TABLE 6-1, and are discussed in Subsection 6.3.6.

6.3.5 Fire-flow Scenario Analysis

For this master plan revision, the fire flow scenario was not analyzed.

6.3.6 Analysis Results and Recommended Improvements for the Existing System

Various alternatives were considered to correct the hydraulic deficiencies identified in the hydraulic analysis. The proposed improvements were evaluated for their ability to correct the deficiency and for their cost-effectiveness as compared to other alternatives.

Steady-State Deficiencies

The deficiencies identified in the ADD, MDD, and PHD simulations for the existing system were analyzed in detail using the computer model by adding proposed improvements, reviewing the updated results, and repeating this process until acceptable results were obtained.

The distribution system was analyzed to identify areas of the system that experienced pressures below 40 psi or above 125 psi (criteria identified in TABLE 6-1). Various steady-state planning scenarios were used to analyze system pressures under different demand conditions to verify adequate system pressures. Where low pressures were observed during the analysis, one or more approaches were used to mitigate the low-pressure problem. In some cases, low pressures can be corrected with no physical improvement, such as by increasing the pressure setting of an upstream pressure regulating valve. However, sometimes substantial improvements may be required. Improvements may include replacing older pipelines with larger diameter pipelines to reduce friction losses, constructing new pump stations or pressure regulating stations, or modifying the boundaries of an existing pressure zone.

High velocities in water pipelines can also be an indication of an operational deficiency, and can lead to scouring of the pipe lining material or increase the chances of a valve failure. Increased velocities contribute to increased head loss, usually resulting in a less efficient water distribution system. Higher velocities may be acceptable for short-term operation, such as when needed for fire-flow, but otherwise should be lower where practical. The planning scenarios used to analyze the Cypress Ridge System for pressure deficiencies were also used to evaluate the velocities under the same demand periods (ADD, MDD, and PHD). The velocity criteria used to evaluate the distribution system for each demand period were defined in TABLE 6-1.

As stated in footnote ‘a’ of TABLE 6-1, “If velocity or headloss in a pipeline exceeded the criteria listed but did not result in low pressures in the system, the pipeline was not recommended for replacement.” Thus, pipelines with velocities above the criteria identified in TABLE 6-1 but below 10 fps were reviewed for excessive pressure loss resulting in low pressures or excessive energy use. Where the velocities did not appear to contribute to pressure problems or excessive pumping, then no deficiency was identified and no improvement was proposed.

The hydraulic analysis showed that there were no pressure deficiencies, high velocities or headloss during any of the scenarios; therefore, no capital projects were identified.

Note: The Cypress Ridge Zone and Main Zone were analyzed separately in this Master Plan, however – as stated in Section 5.5 – Operations should consider combining the Main Zone and Cypress Ridge Zone to improve supply redundancy.

TABLE 6-3 Existing System Deficiencies and Recommend Improvements for ADD, MDD, and PHD

Deficiency/ Alternative Number	Location	Deficiency	Recommended Improvement
1.2.0	**Main Zone**	**MDD & PHD Pressure (>125 psi)**	Create Falcon Crest Regulator Zone; install PRVs to reduce pressure to within the 40-125 psi range
1.2.1	Cathedral Ln/Century Ln Area		

SECTION 7

Water Quality Evaluation

The purpose of this section is to provide documentation of GSWC's water quality assessment effort for the Cypress Ridge System. Water quality of local groundwater was evaluated based on current federal and state standards and rules.

7.1 Current Status of Drinking Water Quality

The Cypress Ridge System is supplied by eleven wells: Cypress Ridge (CR) Wells #4, #5, #6 and #7, and Rural Water (RW) Wells #2 (El Campo), #3 (Fowler), #4 (Ridgemont), #6 (El Campo), #7/5A (Ridgemont), #8 (Lopez High) and #9 (Lopez High). However, CR Well #4 and RW Wells #8 and #9 have been taken offline due to high and inconsistent nitrate levels. The system currently has no emergency interconnections, but will be connected to the water system of the Nipomo Community Services District (NSCD) by 2021.

The Cypress Ridge system is essentially run as two systems due to a valve that isolates it into two sections: Cypress Ridge ("Cypress Ridge Zone") and Rural Water ("Main Zone"). Both sections have an active blend to reduce nitrate entering the system. The Rural Water section has an additional blend that is currently inactive due to high nitrates in both contributing sources.

CR Wells #4, #5, #6 and #7 are permitted to blend in the two CR Reservoirs to reduce nitrate levels prior to entering the distribution system. CR Well #4 nitrate levels have averaged 23 mg/L between 2016 and 2019, which is well above the nitrate MCL of 10 mg/L (as N). The other CR wells show an increase in nitrate levels during winter months and rain events. CR Well #7 has exceeded the nitrate MCL on multiple occasions reaching 11 mg/L (as N). CR Well #6 has been as high as 8.6 mg/L (as N). This leaves CR Well #5 as the primary source for blending purposes. CR Well #5 has been as high as 6.9 mg/L (as N), but its average between 2016 and 2019 has been 4.9 mg/L (as N). All the sources in the Cypress Ridge blend have significant amounts of nitrate and produce an average blended effluent of 5.9 mg/L (as N). It is not possible to add Cypress Ridge #4 to the blend at this time because it averages 23 mg/L (as N) and would potentially cause the blend to exceed the MCL for nitrate.

RW Wells #2, #4, #6 and #7/5A blend in the two Rural Water (El Campo) Reservoirs to reduce nitrate levels prior to entering the distribution system. All wells are currently below the nitrate MCL of 10 mg/L (as N), but there is a historic trend of these levels rising during winter months and rain events. Nitrate levels in RW Wells #4 and #7 have the most variability. Rural Water #4 fluctuates between 3.6 and 6.8 mg/L (as N) and Rural Water Well #7 varies between 4.5 and 9.3 mg/L (as N). RW Well #6 is consistently near 9 mg/L and RW Well #2 is typically at half the MCL but can spike to 8 mg/L during heavy rain events.

RW Well #3 enters directly into the distribution system. It averages a nitrate level 3.9 mg/L (as N), but it has gone above the MCL in the past. To mitigate any potential for serving water above the MCL, a nitrate analyzer has been installed on Rural Water Well #3 and it will shut off the well in the event the nitrate level rises to 90% of the MCL.

RW Wells #8 and #9 have been permitted to blend prior to entering the distribution system. However, both wells have historically exceeded the nitrate MCL of 10 mg/L (as N) and were taken offline prior to Golden State Water acquiring the system. In November of 2016, high nitrate levels were confirmed by GSWC with Rural Water Well #8 sampled at 24 mg/L (as N) and Rural Water Well #9 sampled at 23 mg/L (as N). Both wells remain offline and inactive with until adequate treatment is available.

At various facilities, 12.5 percent liquid sodium hypochlorite is injected to provide a disinfectant residual in the water entering the distribution system. CR Wells #4, #5, #6 and #7 are chlorinated at the blend prior to entering the CR Reservoirs. RW Wells #2, #4, #6 and #7/5A are chlorinated at the blend prior to entering the El Campo Reservoirs. RW Well #3 is chlorinated at the well site.

The drinking water quality of the Cypress Ridge System must comply with the Safe Drinking Water Act (SDWA), which is composed of primary and secondary drinking water standards. Compliance with primary drinking water standards is regulated by the U.S. Environmental Protection Agency (EPA). Compliance with both primary and secondary standards is required by the State Water Resources Control Board Division of Drinking Water (DDW).

Water quality sampling is performed at the sources and within the distribution system to ensure compliance with regulatory standards. Sources are sampled as prescribed in Title 22 of the California Code of Regulations. Monitored constituents include general mineral, general physical, inorganic, volatile organic, synthetic organic and radiological chemicals. The frequency of monitoring is dependent upon the parameter tested and the concentration of the constituent in the source water. Monitoring frequencies range from weekly to once every 9 years. The parameters monitored include specific constituents of concern (that is, if treatment is provided then the constituent being treated for would be tested), coliform bacteria, heterotrophic plate counts (HPCs) and chlorine residual. The distribution system is tested regularly for coliform bacteria, chlorine residual, general physical parameters and disinfection by-products (trihalomethanes [TTHM] and haloacetic acids [HAA5]). The distribution system is tested weekly for the presence of coliform bacteria at representative locations throughout the system, and one site undergoes further tests for color, odor and turbidity. Collection of disinfection by-product samples is performed on an annual basis.

7.2 Imported Water Quality

The Cypress Ridge System will be connected by a transmission line to the nearby Nipomo Community Services District (NCSD). The water that will come through this interconnection is chloraminated and the mixing of system disinfectants may require improvements to assist with how that is managed. The NCSD is supplied by groundwater and also purchased water from the City of Santa Maria.

7.3 Groundwater Quality

Water delivered to customers in the Cypress Ridge system currently complies with all primary and secondary MCLs; however, treatment is required. Highly variable nitrate levels in all wells require some type of treatment and/or advanced and frequent monitoring.

7.4 Water Quality Evaluation

The following table and discussion provide information on the relevant water quality evaluation for the Cypress Ridge System, including:

- Nitrate
- Perchlorate
- Per- and Polyfluoroalkyl Substances

7.4.1 Nitrate

TABLE 7-1 provides the average, high and low nitrate level for each source in the Cypress Ridge system. Variability in nitrate levels within both active blends and occasionally Rural Water Well #3 provide strong justification for continuous online nitrate monitoring. As previously discussed, spikes and fluctuations have been observed in several sources and seem to be related to weather and source pumping volume. Nitrate monitoring will be continued on the influent and effluent of the Cypress Ridge Reservoirs and Rural Water Well #3. In addition, an analyzer should be installed on the influent and effluent of the Rural Water Reservoirs. All analyzers should also be integrated with SCADA communications, which can be programmed to send alarms and shut down sources when nitrate levels exceed automated set points.

TABLE 7-1 Source Nitrate Levels (October 2015-September 2019)

	Facility Name	Average	Maximum	Minimum
Blended into Cypress Ridge Reservoirs	Cypress Ridge Well #4	22	30	14
	Cypress Ridge Well #5	4.9	6.9	3.8
	Cypress Ridge Well #6	5.4	9.6	3.5
	Cypress Ridge Well #7	6.8	11	5.0
Pumps to System	Rural Water Well #3	3.9	14	3.1
Blended into Rural Water Reservoirs (El Campo)	Rural Water Well #2	5.9	8.9	4.4
	Rural Water Well #4	5.3	6.8	3.6
	Rural Water Well #6	8.8	10	7.3
	Rural Water Well #7/5	6.7	9.3	4.5
Pump to System (offline for high nitrates)	Rural Water Well #8	15.7	24	13
	Rural Water Well #9	18	23	16

More treatment options should be explored for Cypress Ridge as nitrate levels appear to be increasing. There is a general upward trend in the Cypress Ridge system wells, and three sources have already surpassed 20 mg/L (as N). Much of the available water supply in Cypress Ridge cannot be used until more robust treatment systems are in place. Blending is not adequate treatment to bring Cypress Ridge #4, Rural Water #8 and Rural Water #9 back into service.

7.4.2 Percholarate

The current MCL for perchlorate is 6 ug/L. The PHG was changed from 6 ug/L to 1 ug/L in 2015. Because the PHG was changed by the Office of Environmental Health Hazard Assessment (OEHHA), the California State Water Board will be revisiting the current MCL in the future. The future perchlorate MCL should be as close to the PHG as technologically and economically feasible. The level of perchlorate currently detected in Cypress Ridge ranges from <2 (ND) to 3.8 ug/L. Cypress Ridge Well #5 has the highest level at 3.8 ug/L. At present, Cypress Ridge Well #5 is a primary source in the Cypress Ridge Reservoir Blend because it is required to keep the blended effluent from the Cypress Ridge Reservoirs low in nitrate. If the perchlorate MCL is lowered, we may need to evaluate our blended ratios for both nitrate and perchlorate to ensure that the blend complies with both MCLs at all times.

7.4.3 Per- and Polyfluoroalkyl Substances

Per- and polyfluoroalkyl substances (PFAS) are a varied and sundry group of compounds used in a variety of industrial and commercial applications including fire-fighting foams, clothing, metal plating, and upholstery.

As a small public water system, the Cypress Ridge System's wells were not required to be monitored for PFAS including PFOA and PFOS as a part of the third unregulated contaminant monitoring rule (UCMR3).

The following outlines regulatory requirements for PFAS:

- In 2015, the EPA released a health advisory for two PFAS compounds, perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), at a combined total of 70 nanograms per liter (ng/L).
- In July 2018, DDW set a notification level for PFOS of 13 ng/L and PFOA of 14 ng/L with a recommendation for source treatment or removal from service at a combined 70 ng/L. In the absence of a federal MCL, several states are in the process of developing MCL for PFAS.
- In March 2019, DDW issued the first phase of mandatory PFAS testing orders for public water systems across California based on proximity to: airports with fire training/response sites and previous PFOA/PFOS detections. The Cypress Ridge water system did not receive a mandatory testing order in the first phase.
- In August 2019, DDW revised the notification levels from 13 ng/L to 6.5 ng/L for PFOS and from 14 ng/L to 5.1 ng/L to PFOA.

The regulatory requirements for PFAS are expected to develop over the next one to three years. Regulations for this emerging contaminant will be closely monitored by Golden State Water.

7.5 Recommended Improvements

The water quality concerns that were discussed in the previous sections are summarized in TABLE 7-2.

TABLE 7-2 Recommended Improvements to Address Water Quality Concerns

Alternative Number	Alternative Description
1.3.0	**Upgrade Communications Equipment**
1.3.1	Upgrade communications equipment for all wells.
1.4.0	**System-wide SCADA integration**
1.4.1	SCADA integration to better automate all well start-up and shut-down protocols.
1.5.0	**Nitrate Analyzers**
1.5.1	Purchase and install nitrate analyzers at El Campo Reservoirs’ influent and effluent; integrate all nitrate analyzers with automated controls through SCADA system.
1.6.0	**Nitrate Treatment Feasibility Study and Implementation**
1.6.1	Feasibility study of nitrate treatment options for RW Wells #8 and #9 and implement recommendations.
1.7.0	**Monitor Chlorine Residual**
1.7.1	Analyzers for chlorine with integration into SCADA should be installed at the three points of chlorination

SECTION 8

System Condition Assessment

The purpose of this section is to provide documentation of GSWC's system condition assessment effort for the Cypress Ridge System. This section is organized as follows:

- Previous system condition assessment efforts
- Updated condition assessments

8.1 Previous System Condition Assessment Efforts

More than 10 years ago, GSWC conducted several facility condition assessment efforts, working with multiple engineering consulting companies to develop a complete condition assessment for each of the Company's systems. Facilities in the Cypress Ridge System were not addressed in this effort, as GSWC had not yet acquired the Cypress Ridge System.

Generally, the purpose of these studies was to inspect and evaluate existing facilities to determine if upgrades would produce significant benefit to offset expenditures. These studies included the following information:

- Evaluations of the safety of the facilities
- Outstanding code violations
- A general evaluation of condition and reliability

8.2 Updated Condition Assessments

For this Master Plan, GSWC Operations and Planning personnel reviewed the condition of plant facilities and pipeline data within the Cypress Ridge System in order to identify the facilities requiring upgrade or replacement. For the pipeline conditional assessments, no specific recommendations were made based solely on condition, but age and material were considered along with pipeline leaks/breaks and input from operations staff.

8.2.1 Facility Condition Review

The purpose of this review was to identify plant improvement projects based on the following:

- Operational needs and requests
- Common items that are not installed at all plant sites
- Recommendations from the previous condition assessments that were not installed

GSWC reviewed each of the following elements to identify potential recommended improvements at each facility:

- Electrical
- Mechanical
- Structural
- Other site improvements

TABLE 8-1 summarizes the recommendations that were developed as a result of the system condition assessment review.

TABLE 8-1 2017 Condition Assessment Plant Projects

Alternative Number	Facility	Project Description	Reason	Priority Category
1.8.0	Systemwide	Install generator connection panel and manual transfer switch at well sites	PSPS-related project; install generator connection panel and manual transfer switch (for portable generator connections) at Cypress Ridge #6, Fowler and El Campo (to run Wells #2 & #6)	Short-term
1.9.0	Systemwide	New well	Replace existing well(s) per recommendations in 2019 Water Reliability Study	Short-term
1.10.0	Cypress Ridge Plant	Recoat exterior roof of Reservoir #1, interior and exterior roof of Reservoir #2	Prolongs useful life; based on tank inspection report(s)	Short-term
1.11.0	El Campo Plant	Recoat interior of Reservoir #1, interior and exterior roof of Reservoir #2	Prolongs useful life; based on tank inspection report(s)	Short-term
1.12.0	Falcon Crest Plant	Recoat interior and exterior roof of Reservoir	Prolongs useful life; based on tank inspection report	Short-term
1.13.0	El Campo Plant	Resize/replace boosters	Booster D&E design points unknown and pumps inefficient; resize/replace to improve output capacity from Plant	Short-term
1.14.0	El Campo Plant	Destroy Well #1	Recommendation from 2019 Water Reliability Study; well is a sander	Short-term
1.15.0	El Campo Plant	Destroy Well #5	Recommendation from 2019 Water Reliability Study	Short-term
1.16.0	Cypress Ridge #8	Destroy Well #8	Recommendation from 2019 Water Reliability Study; low producing (~10 gpm) well	Short-term
2.1.0	Lopez High Area	Construct reservoir and booster station	Recommendation from 2019 Water Reliability Study; facilitate treatment or blending and also provide improved fire flow for school	Long-term
2.2.0	Fowler Well #3	Major well rehabilitation	Recommendation from 2019 Water Reliability Study; major rehab will extend useful life of well for 10+ years	Long-term

8.2.2 Pipeline Condition Review

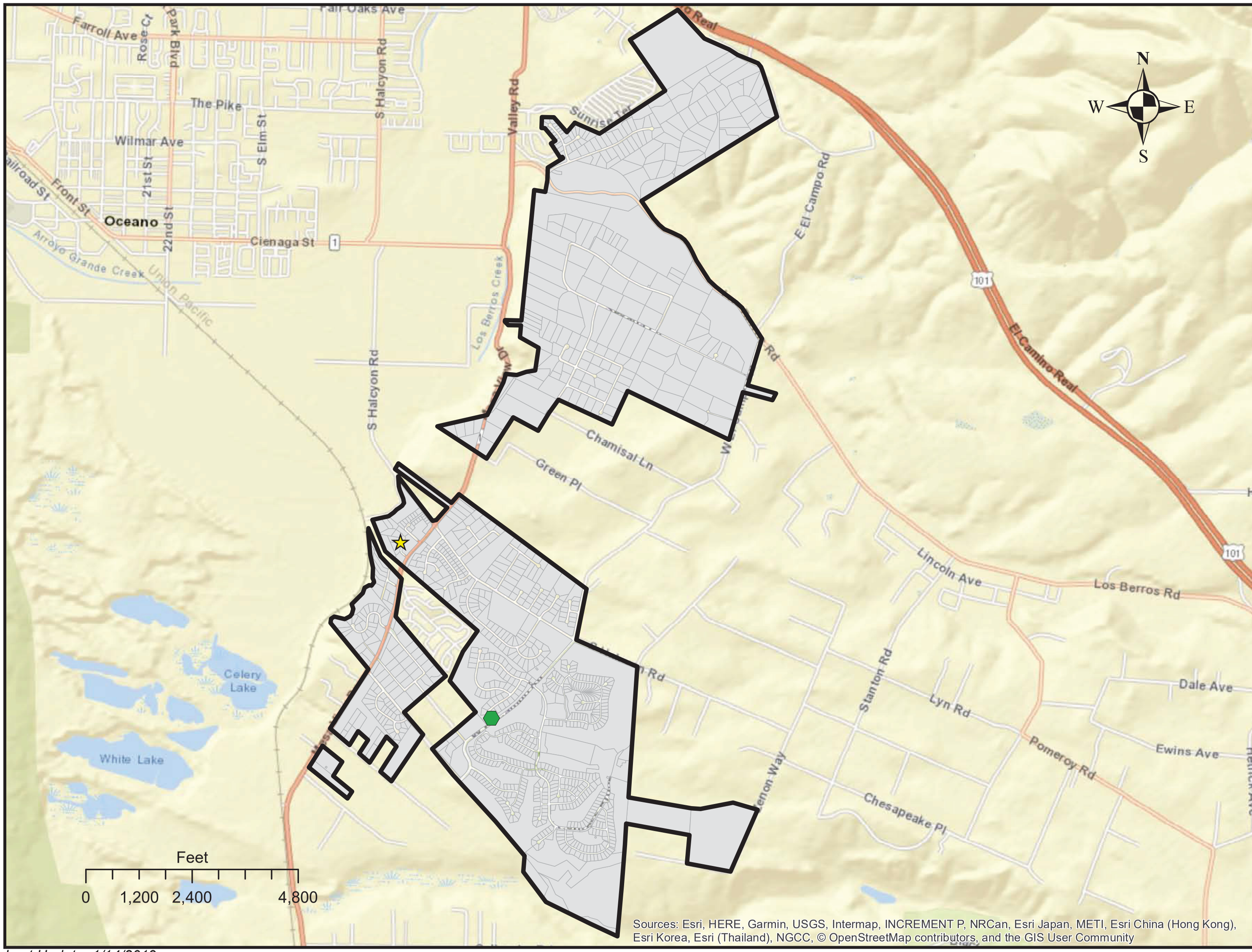
In addition to facility condition, GSWC monitors distribution system condition through the tracking of pipeline leaks/breaks on an annual basis; FIGURE 8-1 is a map of the leaks in the Cypress Ridge System from 2014 to 2018. This information was used, along with additional risk assessment analysis, to make recommendations regarding potential CIP projects and in the prioritization of those projects. (See GSWC's *Pipeline Management Program Report* and *Risk Based Asset Management Program Report*.)

TABLE 8-2 2017 Condition Assessment Pipeline Projects

Alternative Number	Recommended Improvement	Reason	Priority Category
1.17.0	Interconnection with neighboring purveyor; Install 500 LF of 8-inch main	Redundant supply in case of emergency; Arroyo Grande main near existing infrastructure at north end of system	Short-term
1.18.0	Replace Normally-closed valve with PRV or combine zones (add secondary connection at Willet/Brant)	Allow the Cypress Ridge Zone to be connected to the Main Zone (El Campo area), where purchased water will be delivered	Short-term
1.19.0	Los Berros Rd, Sevada to Falcon Crest; Approximately 5,100 LF of 8-inch PVC	Improve water supply reliability to the northern section of the Cypress Ridge System	Short-term
2.3.0	Extend purchased water transmission line to the Cypress Ridge Zone; Approximately 2,300 LF of 8-inch PVC	Connect new main to Cypress Ridge reservoirs as secondary location to receive NCSD water	Long-term

Figures

CYPRESS RIDGE SYSTEM LEAK MAP 2014 - 2018



Last Update: 1/14/2019

Year & Number of Leaks

- 2014 - 0 Leaks
- 2015 - 0 Leaks
- 2016 - 1 Leak
- 2015 - 0 Leaks
- 2018 - 1 Leak

Golden State Water Company
A Subsidiary of American States Water Company

SECTION 9

Capital Improvement Program

The capital improvement program (CIP) is an essential component of this water master plan. The CIP summarizes recommended facilities, and establishes the priority and timing of necessary improvements. The recommended improvements were analyzed and evaluated in the previous sections of this report.

The recommended improvements were prioritized into two categories—short-term (existing system) or long-term (2035 system)—to identify when these improvements are required. The project selection and prioritization process considered various issues, including existing deficiencies, projected demands, water quality, regulatory compliance, reliability and facility condition.

9.1 Cost Estimation

No cost estimates are included in this master plan, as the final costs of a project, and the project's resulting feasibility, will depend on actual labor and material costs, inflation, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Prior to design and construction of any recommended project in this master plan, a detailed project cost estimate will be created.

9.2 Project Prioritization

The following descriptions define how projects were prioritized into one of the two categories:

- **Short-term improvement projects** were based on deficiencies identified in the existing system. Deficiencies included supply and storage, hydraulic, condition assessment, and water quality. Operational improvements were included as a short-term improvement only when a significant short-term benefit was identified.

- **Long-term improvement projects** are based on deficiencies identified beyond the short-term planning years through the year 2035. The water system was assumed to be built out by the year 2035. The long-term improvements are typically projects necessary to meet future demands and replace or rehabilitate aging infrastructure.

9.3 CIP Projects

TABLE 9-1 lists the recommended improvements for the Cypress Ridge System. Each project is assigned a unique identification number and a priority: short-term or long-term. Short-term pipeline projects are shown on FIGURE 9-1.

TABLE 9-1 Summary of Recommend CIP Projects

Project ID	Recommended Improvement	Improvement Type	Priority Category
1.1.3	Replace the Sevada Lane PRV with a dual-flow PRV/check valve	Storage	Short-term
1.2.1	Create Falcon Crest Regulator Zone; Install PRVs	Hydraulic	Short-term
1.4.1	SCADA integration to better automate all well start-up and shut-down protocols; upgrade communications equipment for all wells (combine with project 1.3.1)	Water Quality	Short-term
1.5.1	Purchase and install nitrate analyzers at El Campo Reservoirs' influent and effluent; integrate all nitrate analyzers with automated controls through SCADA system[a]	Water Quality	Short-term
1.6.1	Feasibility study of nitrate treatment options for RW Wells #8 and #9 and implement recommendations	Water Quality	Short-term
1.7.1	Analyzers for chlorine with integration into SCADA should be installed at the three points of chlorination	Water Quality	Short-term
1.8.0	Install generator connection panel and manual transfer switch at three well sites	Conditional Assessment	Short-term
1.9.0	Replace existing well(s) per 2019 Water Reliability Study recommendations[a]	Conditional Assessment	Short-term
1.10.0	Recoat interior of Cypress Ridge Plant Reservoir #1, Interior and exterior roof of Reservoir #2	Conditional Assessment	Short-term
1.11.0	Recoat interior of El Campo Plant Reservoir #1, Interior and exterior roof of Reservoir #2	Conditional Assessment	Short-term
1.12.0	Recoat interior and exterior roof of Falcon Crest Plant	Conditional Assessment	Short-term
1.13.0	Resize/replace El campo Plant boosters	Conditional Assessment	Short-term
1.14.0	Destroy El Campo Well #1[a]	Conditional Assessment	Short-term
1.15.0	Destroy El Campo Well #5[a]	Conditional Assessment	Short-term
1.16.0	Destroy Cypress Ridge Well #8[a]	Conditional Assessment	Short-term
1.17.0	Interconnection with neighboring purveyor; Install 500 LF of 8-inch main	Conditional Assessment	Short-term
1.18.0	Replace Normally-closed valve with PRV or combine zones (add secondary connection at Willet/Brant)	Conditional Assessment	Short-term
1.19.0	Los Berros Rd, Sevada to Falcon Crest; Approximately 5,100 LF of 8-inch PVC	Conditional Assessment	Short-term
2.1.0	Lopez High Area construct reservoir and booster station[a]	Conditional Assessment/ Hydraulic	Long-term
2.2.0	Fowler Well #3 major well rehabilitation[a]	Conditional Assessment	Long-term

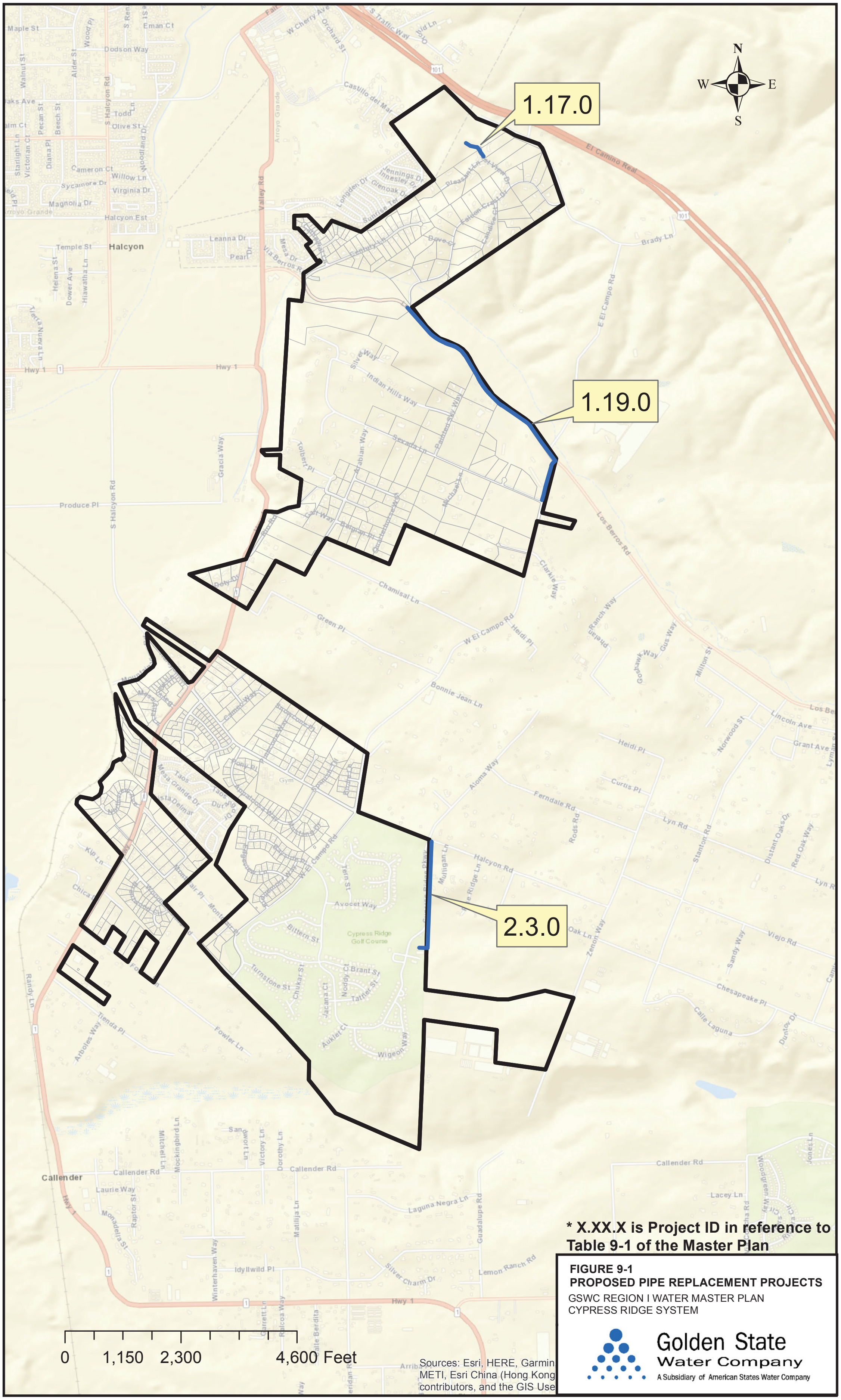
Project ID	Recommended Improvement	Improvement Type	Priority Category
2.3.0	Extend purchased water transmission line to the Cypress Ridge Zone; Approximately 2,300 LF of 8-inch PVC	Conditional Assessment/ Supply	Long-term

[a] Recommendation from 2019 Water Reliability Study.

9.4 Additional Considerations

A Water Reliability Study was prepared by a consultant in 2019 to help determine the appropriate course of action for long-term system reliability due to water quality, production capacity, supply and storage concerns in the Cypress Ridge System; the final report/Technical Memorandum resulting from the Study is included as Appendix C of this Master Plan, and may recommend plant and pipeline projects in addition to those listed above.

Figures



* X.XX.X is Project ID in reference to Table 9-1 of the Master Plan

FIGURE 9-1
PROPOSED PIPE REPLACEMENT PROJECTS
GSWC REGION I WATER MASTER PLAN
CYPRESS RIDGE SYSTEM

Last Update: 11/25/2019

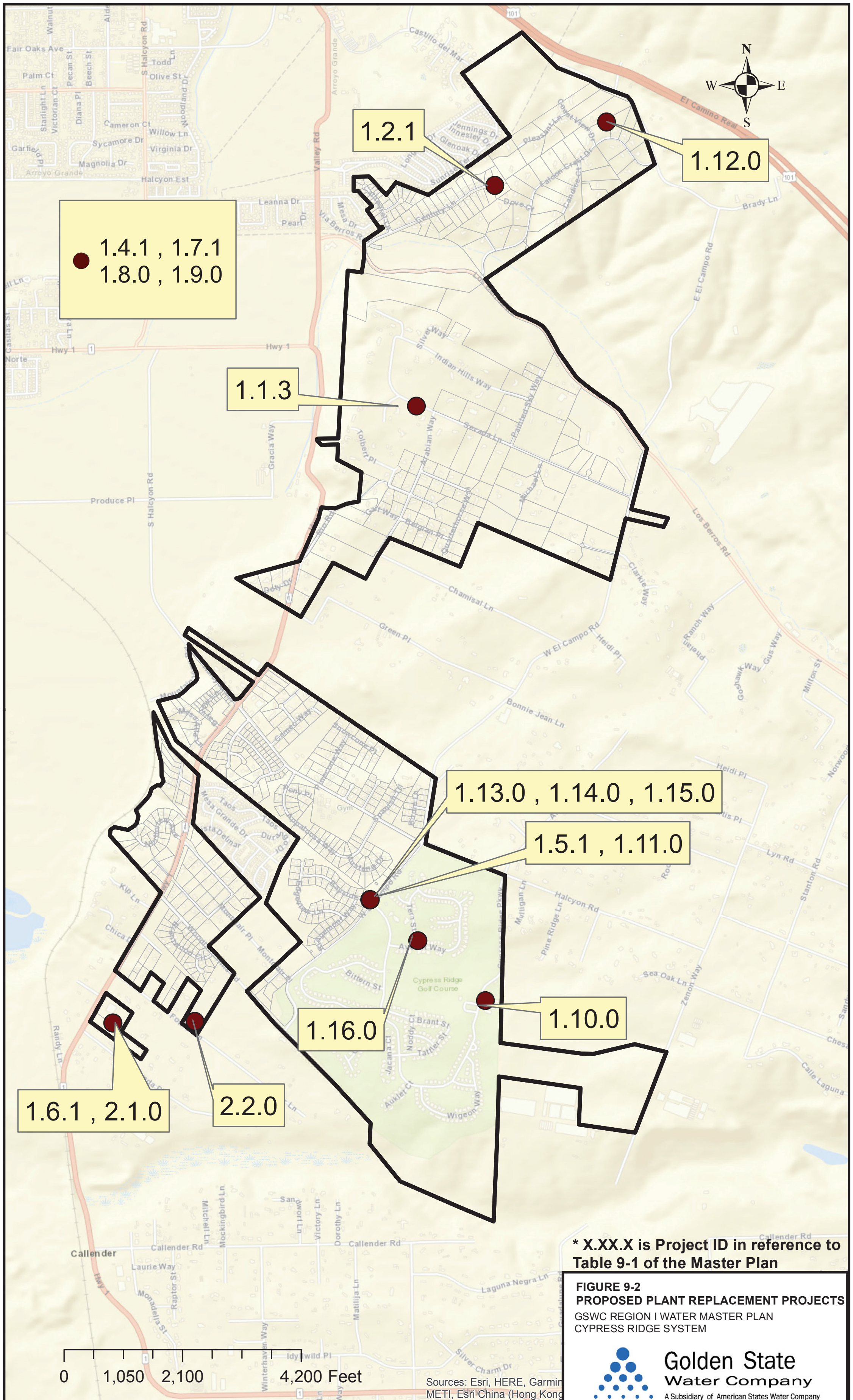


FIGURE 9-2
PROPOSED PLANT REPLACEMENT PROJECTS
GSWC REGION I WATER MASTER PLAN
CYPRESS RIDGE SYSTEM

Last Update: 12/18/2019

SECTION 10

References

American Water Works Association (AWWA). 2005. *Manual of Water Supply Practices M32: Computer Modeling of Water Distribution Systems.* Denver, Colorado.

California Environmental Protection Agency, State Water Resources Control Board, Division of Drinking Water (DDW). 2016. *California Regulations Related to Drinking Water (Titles 17 and 22, California Code of Regulations).* Sacramento, California. June.

California Public Utilities Commission (CPUC). 2009. *General Order 103-A: Rules Governing Water Service Including Minimum Standards for Design and Construction.* Sacramento, California. September.

Corona/Wood Rodgers. 2019. *Water Reliability Study (Cypress Ridge System) – Final Report.* May.

GSWC. 2017. Cypress Ridge System Water Master Plan. Rancho Cordova, California. April.